Working Paper

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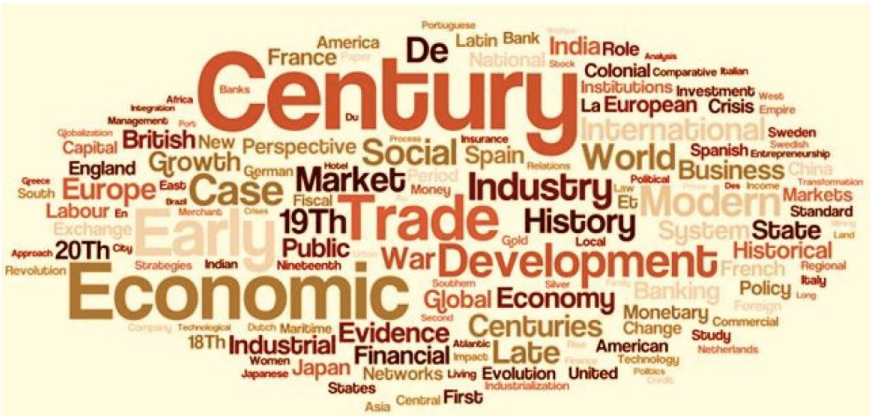

Paul Bairoch Institute of Economic History, University of Geneva, UniMail, bd du Pont-d'Arve 40, CH-1211 Genève 4. T: +41 22 379 81 92. Fax: +41 22 379 81 93

Weather Shocks, Poverty and Crime in 18th-Century Savoy

CÉDRIC CHAMBRU*

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Abstract

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Keywords: Weather shocks; Migration; Crime; Grain Prices; Savoy; 18th century.

JEL: J61, N33, N53, Q10.

*Department of Economics, University of Zurich, Zürichbergstrasse 14, CH-8032 Zürich, cedric.chambru@econ.uzh.ch. I thank my advisors Mathieu Couttenier and Michael Huberman for their continued guidance and support. I am grateful to Guido Alfani, Maleke Fourati, Roberto Galbiati, Luigi Lorenzetti, Jérémy Luchetti, Kostadis Papaioannou, and Mathias Thoenig, as well as participants of the AGRICLIOMETRICS III, EHES 2017 meetings, and seminar audiences at the University of Geneva, and University of Montreal for helpful comments and suggestions. Financial support was provided by the University of Geneva, and the Swiss National Science Foundation (grant number: P1GEP1_161588).

1 Introduction

The effect of economic shocks on interpersonal and intergroup conflicts has been the subject of a growing literature over the last decade (Burke, Hsiang and Miguel, 2015). A large body of this literature provides evidence that negative transitory income shocks are associated with higher risk of conflicts in both historical and contemporary settings (Dell, Jones and Olken, 2014). However, there is less evidence on the effect of adaptive strategies on the mitigation of these shocks. Adaptive strategies are defined as those methods used to reduce communities' vulnerability to recurrent environmental shocks that challenge their living standards. Adaptation to global warming and increased weather variability will require policy interventions to be informed by resilience-relevant scientific evidence to foster effectively the resilience of local communities around the world.

This paper sheds light on the effect of economic conditions on property and violent crimes by exploiting within-province variations in weather-induced negative income shocks in Savoy from 1749 to 1789.[1] In particular, I use the spatial heterogeneity in the migration pattern between lowland and upland communities– due to the ecological variability of the land across the Duchy– to identify how seasonal migration could constitute an efficient buffer against weather-induced income shocks.[2] Migrant labour may, indeed, bring in remittances to supplement communities' resources as well as temporarily relieve impoverished households of the burden of feeding them. I assemble a new data set on the occurrence of property crimes and violent crimes 1749–89 at the provincial level. I combine these data with reconstructed seasonal temperature data, population census data, as well as data on annual wheat prices in two different provinces, grape harvest dates and annual wine prices.[3] I document how weather shocks could translate into transitory negative income shocks for local communities. I show that warmer temperatures were associated with earlier grape harvest date (GHD) and lower wine prices. This is consistent with previous findings in the literature (Daux et al., 2012; Meier et al., 2007), and can be explained by the fact that temperatures and growing season length are a critical aspect for the cultivation of winegrapes because of their major impact on

[1] During the 17th century and the first half of the 18th century, Savoy has been occupied on many occasions by foreign troops. In 1749, a seven-year rule of the Holy Roman Empire ended, and for the next 40 years, Savoy was not involved in any military conflict. Political and judicial institutions remained very stable during this period.

[2] In the remaining of the paper, I use *Savoy* to refer to the duchy of Savoy, whereas I use *Savoie* to name the province constituting part of the duchy. Chambéry was the capital city of both the duchy of Savoy and the province of Savoie. See Section 2.1.

[3] I derive temperature series from paleoclimatic reconstructions, and check them against various historical records. Paleoclimatology is the study of past climates. Using a combination of different types of proxy records, including ice cores, tree rings, and sediment cores, paleoclimatic studies are able to infer local fluctuations in temperature and precipitation for a given year (Bradley, 2015).

grape ripening and fruit quality: warmer temperatures fasten vegetative growth and increase the ripening potential. Warmer temperature was also associated with higher wheat prices.[4] Bread made up the bulk of the Savoyard consumption basket in which vegetables, fruits, and livestock products marginally supplemented the diet (Nicolas, 1979). This means that variations in grain prices had a larger impact on household real income than variations in wine prices. In the face of an economic downturn, joblessness, and/or a rise in food prices, the inability to secure financial resources may lead individuals to turn to illegal income-generating activities, because these individuals who lack economic resources have greater incentives to commit crime (Becker, 1968). More specifically, Becker suggests that individuals weigh the benefits and costs of committing a crime, so that any changes in the relative gains and the level of crime deterrence might have an impact on the incidence of crime.

I use panel estimates with province and time fixed effects to compare crime rates in provinces with high seasonal migration rates with provinces with low seasonal migration rates. I find that transitory negative income shocks associated with weather shocks significantly increased the occurrence of property crimes, and significantly decreased the occurrence of violent crimes. A one standard deviation increase in temperature increased property crime rate by 6.4 per cent, and decreased violent crime rate by 6.2 per cent. I provide additional evidence that the increase in property crimes were partially driven by the need to survive. An increase in temperature affects property crimes involving the theft of edible product. A fall in the opportunity cost of illegal activities due to shrinking agricultural income could increase the pay-off of committing thefts and, in turn, increase the probability of committing property crimes. On the contrary, the drop in real income caused by temperature shocks may explain the negative relationship between warmer temperature and violent crime rates. Despite lower wine prices, alcohol consumption, a major criminogenic trigger, is likely to have decreased as households' income decreased.

In 1734, Pierre Lavin, an inhabitant of the province of Chablais, migrated and was later arrested for begging by the French *Maréchaussée* in Lyon. During his prosecution, he declared that "because all harvest failed last year in his homeland, he had no choice but to leave to beg for food here and there".[5] Migration is an efficient coping mechanism if one has the ability to secure a job and stable earnings. Using a key institutional change put in place by new immigration regulations in the United States, Freedman, Owens and Bohn (2018)

[4] This results is also in line with previous findings in the literature (Franck and Galord, 2017; Jia, 2014.

[5] Cited in Gutton (1971). Archives Départementales (hereafter A.D.) Rhône, Série B, Maréchaussée, dossier de P. Lavin.

show that, among immigrants, the likelihood to commit income-generating crimes is higher when they are prevented from participating in the local labour market. The case of Pierre Lavin is certainly not representative of the migration outcome of Savoyard migrants, and many contemporaries and historians highlight that seasonal migration constituted a significant source of income for local communities (Grillet, 1807; Guichonnet, 1945; Verneilh-Puiraseau, 1807). Seasonal migration, therefore, could have offered a viable alternative to crime for generating income and as such reduced the expected returns to crimes against property. This may, in turn, reduce the incidence of property crimes during transitory economic shocks. Drawing on data from Becchia et al. (2012), I exploit spatial variations in seasonal migration rates to show that it reduced the need for stealing to survive, and was an efficient strategy to mitigate the negative effect of weather shocks. An additional percentage point in the seasonal migration rate reduced the incidence of property crime by 1.3 per cent. Historical evidence suggests that the cash inflow generated by seasonal migrants, as well as the temporary relief of Malthusian constraints, contributed to the mitigation of adverse weather shocks.

Related literature. My work relates the literature that studies the linkages between weather variability, agricultural risks, vulnerability, and migration (Feng, Krueger and Oppenheimer, 2010; Jha et al., 2018; Marchiori, Maystadt and Schumacher, 2012; McLeman and Smit, 2006). Ratha (2005, pp. 32–3) emphasises on the positive effects of remittances. Remittances represent a net fiscal gain for countries of origin, provide currency for importing scarce inputs, and can serve as a buffer against negative income shocks in migrants' home countries. Yang and Choi (2007) show that, in Filipino households with overseas migrants, remittance inflows from overseas replace up to 60 per cent of exogenous declines in income. Focusing on internal migration in Tanzania, Kubik and Maurel (2016) find that weather shocks are an important migration driver through their effect on agricultural income. In particular, households specialised in farming are twice as likely to migrate than households, which derived less than 75 per cent of their income from agriculture.

My findings also contribute to a prior literature that examines the determinants of interpersonal conflicts. For instance, Axbard (2016) studies how climate-induced changes in income opportunities for Indonesian fishermen affect the number of piracy attacks. An improvement of fishing conditions significantly increases the income of fishermen and significantly reduces the level of sea piracy. In particular, they show that the effect of negative income shocks is smaller in areas with many alternative other legal income opportunities, which is consistent with the fact that the opportunity costs drive, at least partially, the relationship between transitory negative income shocks and crime. Focusing on contemporary India, Blakeslee

and Fishman (2018) find that a one standard deviation increase in temperature increases crime rates by 3 per cent. Adverse weather conditions during the growing (monsoon) season lead to substantial declines in agricultural output and income, and a significant increase in property crimes and violent crimes.[6] In 19th-century Bavaria, negative transitory income shocks associated with adverse weather conditions resulted in a strong increase in property crimes and significantly fewer violent crimes (Mehlum, Miguel and Torvik, 2006). In particular, Mehlum, Miguel and Torvik posit that the decline in violent crime rates is driven by a reduction in alcohol consumption. Many historians of crime have related alcohol consumption and drunkenness to violent behaviour. Because alcohol lowers inhibitions, impairs a person's judgement and may exaggerate the offence taken, an increase in alcohol consumption could lead to a surge in violent crimes (Brennan, 1988; Greenshields, 1994; Lecoutre, 2010; Phillips, 2014). Further empirical evidence from 19th-century Prussia (Traxler and Burhop, 2010) and 19th-century France (Bignon, Caroli and Galbiati, 2017) supports this underlying mechanism. Traxler and Burhop assemble data on beer production, rye prices, seasonal rainfall and crime in 19th century Prussia, and show that beer consumption had a strong and highly significant impact on violent crimes. In particular, they show that rainfall shocks, a proxy for negative transitory income shocks, had no impact on violent crime once they account for beer consumption. Bignon, Caroli and Galbiati use geographical variations in the timing of the phylloxera crises to identify the effect of negative income shocks on property and violent crime rates. In wine growing areas, the contagion by phylloxera resulted in a significant decrease in wine production, and represented a strong exogenous income shock. On average, property crime rates subsequently increased by 18 per cent, and violent crime rates decreased by 12 per cent.

The remainder of the paper is organised as follows. Section 2 provides historical background and discusses how seasonal migration could possibly mitigate the effects of weather shocks. Section 3 reports data sources and the dataset construction, and provides descriptive statistics. Section 4 describes the estimation strategy, quantifies the effect of weather shocks on the incidence of crimes, and considers a number of robustness checks. Section 5 concludes.

[6] Dix-Carneiro, Soares and Ulyssea (2017) also find that regions facing a decline in economic conditions experience relative increases in crime rates (homicide) in Brazil. They document that trade-induced shocks to regional economies based on changes in sector-specific tariffs deteriorate local labour market earnings and employment rates, which in turns increase criminal activity.

2 Historical background

In this section, I present a historical overview of the Savoyard economy and its vulnerabilities to weather shocks during the 18th century, before detailing how seasonal migration could help local communities to mitigate adverse weather conditions. The duchy of Savoy was land of contrast: in the north and the west, areas with higher population densities and a rain-fed agrarian economy centred on the production of grains; in the east, the mountainous mass precluded the intensive cultivation of grains and pasture-based livestock production had a more central position in the agricultural mix. If many institutional and tax reforms that occurred during the first half of the 18th century, agriculture experienced little innovations so that total agricultural output was stagnant and could barely sustain population increases. Yields remained static during this period and close to the subsistence level, leaving the local communities vulnerable to adverse weather conditions. Harsh climate conditions and the lack of activity during winter, in particular in hilly areas, pushed many inhabitants to seasonally migrate and find work outside the duchy. Migration offered the opportunity to earn an additional income and temporarily reduced population pressure. Overall, several estimates suggest that migrants could have made up to 30,000 individuals, about 10 per cent of the total population, by the end of the 18th century.[7]

2.1 Administrative organisation

By the early 18th century, the duchy of Savoy had been an independent political entity since the eleventh century.[8] In 1720, the Treaty of The Hague ended the War of the Quadruple Alliance, and attributed Sardinia to the dukes of Savoy, to whom it brought the royal title. The newly-formed Kingdom of Sardinia then encompassed Aosta Valley, Nice, Oneglia, Piedmont, Sardinia and Savoy (Figure 1). Savoy, itself composed of six provinces and two bailiwicks,[9] was then an administrative division of the new political entity (Figure 2).[10]

[7] For a general overview of the Alpine economy and migration movements during the early modern period, see Siddle (1997); Fontaine (1998); Fontaine and Siddle (2000).

[8] The County of Savoy emerged in the early 11th century as a state of the Holy Roman Empire, but was granted imperial immediacy in 1331. After several phases of territorial expansion, it was raised to a duchy in 1416.

[9] These two bailiwicks were constituted as the province of Carouge by letters patent of 2nd May 1780.

[10] Due of its strategic location, Savoy has been occupied several times by France and the Holy Roman Empire for short periods. In 1562, the capital city was transferred from Chambéry to Turin in Piedmont, which afforded better defences against repeated invasions. Institutionalised in the mid-16th century, the Senate of Chambéry, a court of appeal, was then the main ruling institution in the duchy until the creation of intendants in the early 18th century. Within each province, there was a court of first instance called *judicature-mage*, and responsible for judging criminal cases. For a detailed account of the evolution of the senate and its criminal policies from the 16th century onward, see Laly (2010).

Savoy was a laboratory of enlightened despotism during the 18th century. It experienced long before the rest of Europe efforts toward fiscal justice, state-led education, significant growth of its social welfare system, and the opportunity for peasants to free themselves from seigniorial rights (Devos and Grosperrin, 1985).[11] Thus, Victor Amadeus II took advantage from the repeated French invasions to re-assert his authority over the kingdom.[12] In an attempt to unify bureaucracy, he pressed on with reforms to purge some seigniorial institutions, to standardise financial practices, and to institute local intendants in each province (Devos and Grosperrin, 1985; McCluskey, 2009; Storrs, 2013; Symcox, 1983). These changes contributed to the rise of the fiscal-military state during the 18th century. Storrs calculate that, in 1747, the army totalled 56,000 men, so that one man out of forty-five was in the military.[13]

The office of intendants were not venal, and only meritocratic individuals were appointed. Although not compulsory, having a doctorate in Law was the norm. In addition, individuals often had to have served as lawyer, and judge, most of the time voluntarily, and later been as member of the Senate, before having the opportunity to be appointed as intendant. Compensation was then relatively low. Intendants received £1,800 a year to cover their life expenses and the various costs related to their position (Bouverat, 2013*b*; Devos and Grosperrin, 1985).[14] Nobles despised these positions that attracted individuals from the bourgeoisie or individuals with a low-economic status who were willing to climb the social ladder. Thus, in the 1770s, the French ambassador in Turin noticed admiringly that:

> "[...] civil officers had a more studious and seclude life than the clergymen themselves; one expects them to have austere morals and behaviour. [...] Positions in the administration are filled mostly by men born in the lower classes, whose studies only shaped their superiority over the nobility, which is reluctantly ruled by them."[15]

From the 1720s onward, every province had one intendant responsible for, among other things, the collection of taxes and the maintenance of public infrastructure, such as roads and

[11] See Chambru (2019, Chap. 3) for more details about fiscal reforms and organisation.
[12] France invaded and occupied Savoy twice under the rule of Louis XIV, between 1690–6 and 1703–13, respectively. For a review of the French occupation policies, see McCluskey (2009).
[13] In comparison, on average, one man out one hundred was a military in France.
[14] The intendant general in Chambéry received a higher wage, £3,000, given that he was also intendant of the province of Savoie. In comparison, the average income of a farming household amounted to £200 a year during the 18th century.
[15] Cited in Bruchet (1908).

dikes.[16] Intendants also sent monthly reports depicting the social and economic situation in their province to the intendant general in Chambéry, who could then take measures to better cope with sources of distress.[17]

Along these reforms, Victor Amadeus II enforced another edict in May 1717 enacting the suppression of begging (*sbandimento della mendicità*), and the creation of charity hospitals and almshouses in every town across the kingdom. He intended to establish a uniform system of poor relief, which would be able to meet the needs of the poor at the local level. By 1726, 399 institutions were nominally existing, though only one-fifth were well-functioning. Further reforms took place in the 1740s, strengthening the network of charity institutions across the kingdom, and changing the policy focus towards young able-bodied adults to counter the effect of unemployment and proletarianisation (Cavallo, 1995).[18] Previously ignored by the poor relief system, young able-bodied adults represented the bulk of criminals in 18th-century Europe (Lecoutre, 2010). With 63 charity institutions, half of which were hospitals, the duchy of Savoy was then doing relatively well compared to the rest of the kingdom (Bouverat, 2013*b*).

2.2 Climate, weather variability and institutional relief

Located in the Western Alpine region, the duchy of Savoy is under the influence of a continental climate with harsh winters (snow and prolonged frost), and warm and dry summers. Topographic features, however, play a key role in determining local climate patterns, in particular due to the slope, aspect, and exposure of the surface to sunshine. Temperature level thus varies with elevation. On average, the temperature lapse rate in the Alps ranges from -0.54° to -0.58°C per 100 meters (Beniston, 2006; Gobiet et al., 2014; Rolland, 2003).[19] As altitude increases, the growing season (number of degree-days) grows shorter and

[16] Intendants' tasks also encompassed the judgement of civil cases as well as appeals from seigniorial courts, and the monitoring of weights and currency in use in their province. On daily basis, intendants also collaborated with provincial governors, who were in charge to execute the daily military tasks. These included the defence of the Savoyard state, sending troop to oblige recalcitrant communities to fulfil their tax obligations, the supply of escorts for criminals condemned to the royal galleys, and the fight against smuggling activities (Storrs, 2007). See Esmonin (1960) for a more detailed description of the role of intendants.

[17] Because these reports were not systematically preserved, it is impossible to reconstruct consistent series over time. Figure 3 displays the annual number of natural disasters (drought, epizootic, flood, hail, storm, and wildfire) mentioned in these reports between 1713 and 1792. A.D. Savoie, SA 5420 – 5482.

[18] For instance, the municipal workhouse in Thonon-les-Bains provided lodging to thirty six poor in 1789, in exchange for carding and weaving wool under the control of four weavers and three traineeships. In Turin, the *Ritiro di S. Gio' di Dio*, a weaving manufacture, had about 230 inmates in the 1780s. On the functioning of workhouses during the second half of the 18th century, see Moody (2001). On the functioning of hospital and people who had recourse to its assistance, see Allegra (2015) and Cavallo (1990).

[19] That means that, under similar climatic conditions, the rate of temperature decrease is about 5.6°C per km. By contrast, the level of precipitation tends to increase with elevation. Indeed, atmospheric pressure drops as altitude increases, which fosters condensation and precipitation. Grass-growing is strongly influenced by these climatic factors and by altitude. (Mathieu, 2009, pp. 55-6) reports that annual grass production decreased by

reduces the potential agricultural output. Crops cultivation was still possible for altitudes as high as 2,000 meters above sea level, but to reduce the vulnerability to weather extremes, peasants substituted wheat with rye, which had a better resistance to cold stress (Girel et al., 2010; Viallet, 1993).

Barriendos et al. (2003), Crook et al. (2004), and Schmocker-Fackel and Naef (2010) have suggested that the decades 1740–90 were a period of high flood frequency in the Alps. In general, wet summers were detrimental to the quality of harvests, because the high moisture content of the grains made its storage harder (Brunt, 2004). Wet and cold summers also meant that grapes did not mature as they should, leaving yields to be down compared to normal years.[20] By contrast, a warm and early spring fostered the development of grains and meant an earlier harvest. Early harvests had the advantages of reducing the risk of catastrophic damage to the crop from hailstorms, and preventing the mature crops from drying and rewetting due to rainy spells (Le Roy Ladurie, 2006; Pfister and Brázdil, 2006).[21] During the second half of the 18th century, much of the annual variations in crop yields depended on the year-to-year fluctuations of the weather. Other inputs, such as technology and capital stock evolved slowly and showed little year-to-year variations (Brunt, 2015).

Several episodes of adverse weather conditions occurred between 1749 and 1789. Becchia et al. (2012) review the historiography on climatic conditions in Savoy, and note that a series of dry summers occurred in 1754, 1762, 1766–7, and repeated droughts hampered agricultural output in the 1770s and the 1780s increasing the environmental pressure over a growing population. Similarly, wet summers in 1749, 1751, 1756–9, and 1770 led to repeated bad harvest.[22] For instance, the intendant of Genevois revealed that, in 1770, the harvest fell short of an average one-fifth or less for one-fourth of the parishes. In another two-thirds of the 170 parishes, the level of harvest ranged from one-third to two-thirds of a normal year. In 1789, the prolonged winter had detrimental effect on the harvest all over the province. By October, the total wheat harvest in Genevois amounted to 86,031 *coupes* of Annecy, to be compared with the 122,000 *coupes* in normal years. In addition, the intendant emphasised the limited harvest of fruits and the lower quality of milk products.[23]

approximately 40 per cent for every 1,000 metres of elevation increase.

[20] Late spring frosts were also detrimental to vines, as cold temperatures damaged buds that have started to open and caused plants dehydration. Late frost delayed the development of grapes and reduced overall yields.

[21] Postponement of harvest was also dangerous, as the risk of large dropouts of grains through the harvesting work increased substantially if the grain was getting overripe (Allen and Lueck, 2004).

[22] A series of long and cold winters also occurred between 1766 and 1774, 1778 and 1780, and 1788 and 1789, and led to repeated marked fluctuations in grains prices.

[23] The *coupes* of Annecy is a unit of capacity for grains equal to 88.56 litres. A.D. Haute-Savoie, Série 1 C, 4 178, pièces 6 et 8.

Such failures pushed local population and authorities to use various strategies to mitigate the effects of adverse weather conditions. In June 1759, the province of Chablais experienced an episode of drought followed by continuous rains in July and August. In September, the intendant noted that peasants reaped only half of a normal grain harvest. Apple and pear trees gave no fruit, and there were only few cherries and plums.[24] Later in that year, the king granted a £90,000 tax exemption to reduce "the extreme misery of the peoples", and an additional £40,000 to support poor relief (Nicolas, 1978).[25] The provision of poor relief was, however, really strict. Every city council had to establish comprehensive lists of all poor in its parishes by distinguishing those in absolute misery and those having some very limited resources (Figure 4). In 1769, the king granted 26 *sols* per head to households fallen victim to summer hailstorm, and recognised as poor on such lists.[26] Summer 1766 was hot and dry, and grains withered in the fields, which caused crop failures. Local authorities failed to undertake adequate actions, and in his correspondence, the abbot of Mellarède noticed that "one meets vagrants in Chambéry and elsewhere, in particular in Mians, which is one of their main meeting points. Burglaries, highway robberies, and stock thefts are common events this year".[27]

Beside tax exemption and poor relief, local communities also resorted to other strategies, including occasional smuggling, thefts, and seasonal migration to build resilience to weather shocks and maintain their living standards.[28]

2.3 Living standards

Table 1 summarises the average food consumption (respectable) baskets for the typical Savoyard inhabitant. The Savoyard diet was composed of bread, vegetables and fruits.[29] In 1771, the intendant general estimated that the average daily portion of bread of an adult was 1,600 grams, representing about 80 per cent of the total caloric intake (Nicolas, 1979;

[24] A.D. Haute-Savoie, Série 1 C, 2 72, pièce 13.

[25] In Andilly, the number of baptisms halved in 1759 compared to decadal average. Bouverat (2013*a*) also reports decreasing trends in the early 1770s following years of adverse weather conditions and bad harvests.

[26] On average, each household received about £4, which was sufficient to afford enough grains for about ten days. For instance in Évian-les-Bains, a total of £669 were distributed to 162 households totalling 515 individuals. Wheat cost about £15 per *coupe*. An adult needed approximately 0.68 litres of wheat per day (250 litres annually). A.D. Haute-Savoie, Série 1 C, 2 72, pièce 21.

[27] Cited in Nicolas (1978). Archivio di Stato, Turin, Prima Sezione, M35, Lettre du 13 août 1766.

[28] In Appendix A.1, I provide a detailed account of the effect of weather shocks on poverty, as well as the set of actions undertaken by public authorities and assistance institutions to attenuate the misery of the poor. Appendix A.2 also depicts how livestocks breeding could improve the ability to cope with adverse weather conditions. As an additional source of income and a consumption smoothing asset, livestock was a very efficient strategy to reduce the negative effect of weather shocks.

[29] The intendant of Genevois reported that, in 1789, only one-fifth of the population ate wheat. A.D. Haute-Savoie, Série 1 C, 4 178, pièce 8.

Vermale, 1911).[30] Cheese, a high-protein food source easily storable, and other livestock products supplemented the diet. Meat was not widely consumed.[31] Livestock products were also used to provide an income for paying taxes and buying other products, such as wine, which "is the usual drink among city dwellers" in Chambéry (Daquin, 1787, p. 97). Malanima (2013) estimates that per capita annual wine consumption averaged 150 litres in Northern Italy during the 18th century.[32]

Introduced in the 1730s, potatoes were already consumed in the 1740s, even though their cultivation really expanded after the repeated episodes of food distress in the early 1770s.[33] By 1789, it represented almost one-fourth of total agricultural production in the province of Faucigny. In the province of Chablais, potatoes were so widespread among peasants that the intendant reported that they constituted "most of the food of a large number of peasants, in particular in mountainous areas" (Ferrand, 1979; Nicolas, 1979).[34] In 1787, the doctor Daquin (1787, pp. 33–8) also reported that harvests of potatoes were plentiful, and "so precious for peoples in the countryside, that there is no peasant who does not cultivate them, and that lower people in cities". In Saint-Maxime-de-Beaufort, a village of 2,907 inhabitants in the province of Savoie, the annual production of potatoes amounted to 1,620 *quintaux* in 1793, that is 55 kg per capita (Borde-Vibert-Guigue, 1973).[35]

Despite these improvements, the agricultural productivity of Savoyard farming remained relatively low by European standards from the mid-18th century. Seed-yield ratio averaged 4.6:1 for wheat,[36] and 3:1 for rye (Crook et al., 2004).[37] Yields in viticulture were even lower and often insufficient to meet local demand, and sometimes to provide a living for local

[30] In Nancy-sur-Cluses, the average daily portion of bread of an adult was 1,700 grams (Maistre and Maistre, 1986).

[31] Despite the importance of livestock in the local economy, meat was not widely consumed. Viallet (1993) indicates that, on average, only 37 per cent of the household were able to consume salted pork or salted goat meat during celebration days. Becchia et al. (2012) has suggested that, on average, meat consumption amounted to 20 kg a year in Savoy. In the neighbouring city of Geneva, the annual consumption of meat average to 80 kg.

[32] Higher levels of alcohol consumption were not unusual in early modern Europe, given that wine and beer often replaced water in daily consumption. Junot (2009, 124) estimates that a city dweller in Valenciennes consumed on average 500 litres of beer per year during the 17th century. In Lyon, the average daily consumption of wine was approximately one litre per capita in the 18th century (Durand, 1979).

[33] Lansard (1988) reports that nuns from the Bernadines Order in Conflans consumed annually 10.6 *coupes* of potatoes (approximatively 240 litres) between 1746 and 1750.

[34] A.D. Haute-Savoie, Série 1 C 99, pièce 99, lettre du 26 janvier 1789.

[35] Although cultivated since the early 17th century in the neighbouring regions of Bresse and Piedmont, maize appeared late in Savoy. Arthur Young's travelling account is the first document to mention the cultivation of maize in 1785. In 1787, Daquin mentioned that peasants only began to cultivate maize few years ago in the surroundings of Chambéry. In 1791, the intendant of Genevois reported that the "harvest of maize is negligible because people sown very few of it". A.D. Haute-Savoie, Série 1 C, 4 178, pièce 12.

[36] A.D. Haute-Savoie, Série 1 C, 4 178, pièce 18.

[37] In the province of Tourraine, in central France, the seed-yield ratio was 6.4:1 in the 1760s (Maillard, 1998). In England and the Low Countries, seed-yield ratios exceeding 5:1 were not unusual. De Vries (2006, p. 242) calculates that a minimum of 4:1 ratio was necessary to maintain twenty per cent of the total population in the non-agricultural sector.

producers.[38] The position of grape growing in the Savoyard agricultural mix was relatively marginal, though: its total cultivated area was around five per cent of the total agricultural area (Gex, 1943; Nicolas, 1978; Vion, 1956). To reduce the competition from French products, agricultural and industrial tariffs were raised in the aftermath of the Spanish occupation, thereby leaving staple prices and wine prices more vulnerable to weather whims (Tochon, 1871).

2.4 Population and migration in Savoy

From the 16th century onward, total population grew more rapidly in lowland parishes, thereby leading to higher population density in less mountainous provinces and shifting the demographic center of gravity from 600 metres above sea level in 1561 to 570 metres in 1776. From 1758 to 1776, total population aged over five grew by one per cent a year to reach 330,000 inhabitants.[39] In Queige, difference between crude birth rate and crude death rate suggests that total population increased by 380 individuals between 1758 and 1776, whereas population censuses reported only 174 additional inhabitants. This indicates that an important emigration flow took place over the same period (Becchia and Gachet, 2014).[40] Gachet (2002) has shown that migration rate increased with altitude, and was much higher in mountainous parishes. In Saint-Maxime-de-Beaufort, annual migration involved 7.8 per cent of the population in 1757 and 11.7 per cent in 1787, all migrants being young single men. Other medium-sized towns like Boëge, Flumet, Sallanches, and Samoëns had similar levels of annual migration. By contrast, annual migration in lowland cities was much lower. About five per cent of the population of Aix-les-Bains migrated every year, three per cent in Annecy, and one per cent in Thonon-les-Bains (Bouverat, 2013*b*; Viallet, 1993).[41] Workers from upland valleys continuously streamed below to the plains to find seasonal employment, whereas urban dwellers more rarely migrated, so that these structural differences in migration rates remained relatively stable over the pre-industrial period.[42]

[38] On average, plants yielded 15 to 25 hectolitres per hectare. In comparison, average yields in Vendômois, in Burgundy, amounted to 25–35 hectolitres per hectare (Vassort, 1995).

[39] By 1776, the center of gravity of livestock was 620 metres, which highlights the agricultural specialisation between among lowland and upland provinces.

[40] For an overview on the pattern of migration across the Alps, see Mathieu (2009, pp. 123–7).

[41] Immigration was also significant in early modern Savoy. In Carouge, only 84 heads of household out of 1,086 originated from the city in 1790. Men were coming from France, Switzerland, and surroundings regions of Savoy. In Annecy and Montmélian, about two-third of the married men were born outside these cities (Bouverat, 2013*b*).

[42] For a general overview of push and pull factors and their impacts on migration patterns in early modern Europe, see Lucassen (1987).

Public houses were a common location for alcohol consumption, and contributed to the structuring of individual social relations. Heavy drinking by the poor was, nonetheless, perceived as a social threat by the authorities (Brennan, 1988; Lecoutre, 2010; Phillips, 2014). Ill treatment of women (wife-beating) by drunken men and/or the murder of a rival or an acquaintance in a fight were not unusual events. Lecoutre describes the usual drunkards as a peasant or craftsman aged between 20 and 34, and drinking in public houses every evening and on Sunday.[43] Thus, the seasonal migration of young men may contribute, *de facto*, to a reduction of violent and/or deviant behaviour in provinces of emigration.

Another plausible mechanism through which migration may influence crime propensity is the inflow of remittances and the reduction of the Malthusian constraint. In his early work, Braudel (1966) has characterised mountains as a factory producing migrant labour for other people's usage, thus suggesting that local population used migration to escape the Malthusian positive checks. Recent scholarships, however, have discarded this view by showing that migratory movements varied widely in both size and form. If poverty and need drove some of the migration flow (push factor), temporary and commercial emigration responded to different dynamics. In such cases, emigrants often belonged to wealthier social groups, were well integrated in their local communities, and provided remittances to pay family taxes and local debts (Fontaine, 2003; Maistre, Maistre and Heitz, 1992; Siddle, 1997; Viazzo, 1989). Thus, in Magland in the province of Faucigny, each of the three hundred seasonal migrants usually came back home with about £200 of profits, allowing the community to pay for the £37,000 of grains required to sustain a living.[44] In Ugine, a town of 2,000 inhabitants, annual remittances amounted to approximately £4,000 (Devos and Grosperrin, 1985). More unusual were cases of important donations to provide assistance to the poor. In 1776, Pierre-François Passy, then a successful merchant in Vienna, donated £20,000 to provide assistance to the poor in Arâches.[45]

Using local administrative censuses about migration, Maistre, Maistre and Heitz (1992) estimate that, during the 18th century, merchants amounted to at least 15 per cent of the migrants. The bulk of individuals migrating seasonally or periodically was composed of workers in the building industry, metal workers, agricultural workers, servants and other unskilled occupations. During the second half of the 18th century, total temporary migration

[43] Women represented less than four per cent of the hundreds of judicial cases for drunkenness.

[44] On average, only one third of the total grain consumption was locally produced. Remittances and donations were also often used to established schools. Thus, Joseph Piston made his fortune by exporting *Gruyère* to Turin, and donated £8,600 to establish permanent school in Termignon. Similar donations can be found in numerous villages, such as Albiez-le-Vieux, Avrieux, La Chapelle, Saint-Gervais, Sollières, and Tignes.

[45] A similar case happened few decades earlier when the brothers Genamy, who were successful merchants in Vienna, donated about £30,000 to build an hospital and to cover daily expenses of charitable institutions in Saint-Nicolas-de-Véroce.

represented between 20,000 and 30,000 individuals, i.e. about ten per cent of the total population (Blanchard, 1937; Pérouse, 1930). Paris, Lyon, Northern Italy and South Germany were the preferred destinations. Migrants, sometimes attracted by the opportunities of expanding towns, stayed away for good.[46] For instance, Ivrea, a 4,000-5,000 inhabitants city in Northern Italy, had a permanent micro-community of migrants, mostly merchants, from Tarentaise (Alfani and Gourdon, 2012, pp. 1009–12). Darlu, Brunet and Barbero (2011) use patronymic lineage to show that permanent out-migration was more common among families without land ownership, thereby emphasising the importance of economic conditions for some categories of migrants. The emerging industrial sector often offered opportunities for betterment. An analysis of wedding contracts shows that about five per cent of the total number of weddings in Lyon during the 18th century were contracted by individuals from Savoy (Garden, 1970).[47] In her research about migration in Turin, Zucca Micheletto (2006) reveals that, among migrant bribes in Turin between 1760 and 1791, nearly six per cent originated from the sole village of Bessan in the province of Maurienne. Worsening economic conditions often increased the number of individuals joining the flow of migrants. Thus, during the crises of the 1770s, an administrative clerk reported that

> "the inhabitants of Orcien in Chablais [were] in a miserable situation, after five consecutive years of poor harvest. Having no more access to credit to buy food, most of families [were] willing to out-migrate".[48]

In Le Biot, the community secretary reported that "five families emigrated due to the dearth" that year.[49] More generally, migratory movements and agricultural economies were complementary in Savoy as absences were mostly concentrated during the winter. Even year-long emigration was not too detrimental to agricultural output, given that pastoral agriculture in the uplands was relatively less labour intensive than arable farming. By providing additional income and releasing the Malthusian constraint, migration enhanced the resilience of mountain communities to negative transitory economic (weather) shocks.

[46] Thus, a large number of *frotteurs* (furbishers) in Bordeaux were from the parish of Sainte-Foy-Tarentaise in Savoy. In 1770, forty of them wrote the City Council to blame one of their fellow, named Maurice Blanc, after he repeatedly committed theft. The plaintiffs openly reported Maurice Blanc and asked for his expulsion from Bordeaux to preserve the reputation of the migrant community as honest workers. A.D. Gironde, 12 B 339 (as cited in (n.d., Annexes III, pp. 692–5).

[47] In 1756 and 1783, Savoyard also represented about twelve per cent of the deceased at the *Hôtel-Dieu* (hospital). Besides, about six per cent of the apprentices in silk manufactures also originated from the duchy of Savoy.

[48] A.D. Haute-Savoie, Série C 53, pièce 131.

[49] A.D. Haute-Savoie, Série C 2 72, pièce 23.

3 Data

By 1749, there were six provinces in the duchy of Savoy, each corresponding to an independent judicial division, named the *judicature-mage*. My sample consists of offenders who committed at least one property crime and/or violent crime between from spring 1749 to spring 1789 in one of these six provinces. I use year-on-year seasonal temperature variations at the level of provinces to identify the effect of adverse weather conditions on the likelihood of committing crimes. I digitised and georeferenced the map drawn by Cary (1808, p. 17) to create a shapefile reproducing the administrative borders of Savoy during the 18th century. I use this shapefile to compute the average seasonal temperature anomalies in each province before matching them with crime data, and data on seasonal migration rate. Table 2 reports descriptive statistics at the province level for the dependent and independent variables used in my empirical analysis. The respective data sources are discussed in the following sections.

3.1 Crime data

The Savoyard judicial archives are constituted of approximately 36,000 criminal procedures spanning over the 16th, 17th and 18th centuries. A sample of 11,617 criminal procedures covering the three centuries has been created by local archivists.[50] I use criminal procedures from this sample to assemble a data set gathering information on the location, the date of the event, the course of action, and the actors involved in every property crime and every violent crime occurring between spring 1749 and spring 1789.[51] Property crimes include events such as burglary, larceny, highway robbery, and theft. Violent crimes include events like homicide, assault, insults, and threats. One caveat of using criminal procedures to capture interpersonal conflict lies in the fact that, in early modern Europe, a proportion of crimes did not come before the courts, but were dealt on an infrajudicial level, either by arrangements or retribution (Garnot, 2000; Ruff, 1984).[52] A potential concern is that changes in the nature of the judicial law and the functioning of judicial courts over time might have influenced the level of reporting. The short time span of my sample and the stabilisation of judicial practices during the first

[50] See A.D. Savoie, Série B0, Procédures civiles et criminelles, directes ou en appel, 1559 à 1792, and A.D. Savoie, Série 2B, Procédures civiles et criminelles, appels et directes, (1424–1792). The criminal procedures have been randomly selected by the archivists, but there is no way to guarantee their representativeness. For a detailed description of the judicial archives, see Claus (2013).

[51] Social status and place of residence of the criminal are also included in the criminal records.

[52] In his personal diary, Claude-Antoine Bellod, a carpenter from Grand-Abergement, reported that Pierre Berantin killed Pierre Favre with a cudgel during summer 1776. The priest proceeded to the burial of Favre without informing the judicial authority. Two days later the justice learned about the murder and required the body to be unearthed to be autopsied by a surgeon (Abbiateci, Laffay and Cattin, 1996, pp. 89–91).

half of the 18th century reduce this concern (Laly, 2010). Another concern rises from the fact that changes in state capacity and the ability to enforce the law due to external events, such as wars, may have shifted the opportunity cost to engage in criminal activities. From 1749 to 1789, the political situation was relatively stable, no foreign troops were stationed in the Savoyard territory, and Savoy was not involved in any war.[53] This limits the risk of bias due to political turmoil and violence against foreign soldiers.

Overall, I collect data from 1,918 procedures that involved 3,975 offenders. Violent crimes constitute 52 per cent of all reported crimes, which is consistent with previous estimate in historiography.[54] Additionally, I collect population data at the level of provinces for various years from archival sources and secondary literature and linearly interpolate for missing values.[55]

For each province, I construct a measure of *Total crime* as the ratio of offenders in all criminal procedures per 100,000 inhabitants. Then, I disaggregate criminal procedures by type of criminal offences and create two additional variables: *Violent crime* and *Property crime*. Figures 5 and 6 present the distribution of property crimes and violent crimes over time. In both figures, annual variations are important and can be related to weather conditions discussed in Section 2.2. In general, the forms of theft varied in style and purpose, as did the scope of objects stolen. It included, among other things, money, food, animals, clothes, tissues and furniture. I make use of the information contained in the judicial records to create a sub-category of crime: *Theft of edible products*. It involves any event in which food was stolen. Judicial records, however, do not always state the exact object of theft and hence potential variations in the level of reporting means that this variable may not be exempt of bias. As a consequence, I only use this variable to supplement the baseline estimates, and suggest that increase in property crimes induced by weather shocks were partially driven by the need to survive.

[53] In 1749, a seven-year rule of the Holy Roman Empire ended, and Savoy was not occupied until the invasion of French revolutionary troops in 1792.

[54] Ruff (1984) reports that, throughout the 18th century, violent crimes constituted 58 per cent of the total reported crime in the *Sénéchaussée* of Bazas and 52 per cent in the *Sénéchaussée* of Libourne. In Périgueux, 416 of the 976 affairs (42.6 per cent) brought before the local court between 1720 and 1790 were related to theft (Cameron, 1981, p. 179). Guicheteau (2008, p. 340) analyses 381 criminal procedures from the *pr}'esidial* courts in Nantes between 1760 and 1790. 51.7 per cent of the prosecutions related to violent crimes. In Languedoc, property crimes represented between 51 and 58 per cent of the total reported crime during the second half of the 18th century (Castan, 1977, p. 198). In Normandy, 53 per cent of the criminal procedures analysed by Gégot (1966, p. 105) dealt with property crimes.

[55] Population data for 1793 are from the Cassini website (http://cassini.ehess.fr/cassini/fr/html/index.htm). Population data for 1783 are from Rousseau (1960). Population data for 1719 are from Nicolas (1978, p. 12). Population data for 1776 and 1756–8 are from archival sources. A.D. Savoie, série C 433, Récapitulation des Consignes du Sel des Province du Duché de Savoye pour L'année 1776. A.D. Savoie, série C 434, Paralelle du denombrement des personnes, Bestiaux, et de la Taxe en Sel relative au denombrement.

3.2 Weather data

The historical weather data are taken from the European Temperature and Seasonal Temperature and Precipitation (ESTPR) data set (Luterbacher et al., 2004; Pauling et al., 2006). These data provide European-wide seasonal temperatures and precipitation data at 0.5 × 0.5 degree resolution.[56] Values are interpolated for each grid node from a number of homogenised instrumental data series, reconstructed sea-ice and temperature indices derived from documentary records, and some seasonal temperature reconstructions from ice cores and tree rings. I use the map I digitised to aggregate these weather data to the province-season-year level. To do so, I weight each grid value that intersects a polygon (province) by its relative share in the total area of the given polygon. I then calculate the weighted mean seasonal temperature and precipitation for each set of province i, season s, and year t. Finally, I calculate the seasonal standardised temperature deviation from the long-term mean (1500–1600) for each of the six provinces:

$$Temperature_{ist} = \frac{T_{ist} - \overline{T}_{is}}{SD(\overline{T}_{is})}$$

where T_{ist} is the value of the seasonal temperature in province i during season s of year t. $\overline{T}_{is}$ is the long-term mean (1500–1600) of the seasonal temperature in province i, and $SD(\overline{T}_{is})$ is the standard deviation of the long-term mean of the seasonal temperature in province i. Figure 7 and Figure 8 respectively display the distribution of seasonal standardised temperature deviation and the distribution of seasonal standardised precipitation deviation between 1749 and 1789.

To assess the quality of temperature reconstructions and the robustness of my variable, I use two series of annual grape harvest date (GHD) from the provinces of Chablais and Maurienne (Nicolas, 1978; Tissot, 1887).[57] GHD are tightly related to spring and summer temperatures, and therefore provide a reliable proxy for reconstructing weather conditions in the past. On average, the variation of GHD is about 10 days for 1°C variation of the growing season temperature (Chuine et al., 2004; Etien et al., 2009; Le Roy Ladurie and Rousseau, 2011; Meier et al., 2007). More generally, hot summers tend to be favourable to the development of

[56] Approximately 2,000 square kilometres at the latitude of Chambéry. The total land area of the duchy of Savoy was about 10,500 square kilometres in 1789. In Savoy, there is no instrumental data available before the 1780s. The comparison between these two types of data in the context of 18th-century France, however, shows that the series are highly correlated (Etien et al., 2009).

[57] Nicolas uses vintage bans in Montmélian and its surroundings to build a series spanning 1713–90. Montmélian is a town located 15 kilometres south of Chambéry. Its average elevation is 285 metres above sea level. Tissot reports GHD from 1688 to 1794 in Thonon-les-Bains in the province of Chablais.

grape, whereas cold and wet summers are detrimental to both the quantity and the quality of grapes. I compare Savoyard GHD with series from French Jura (Daux et al., 2012) and neighbouring Switzerland (Meier et al., 2007). These two regions are close to Savoy and subjected to similar weather patterns, so that GHD are expected to move together on an annual basis. Figure 11 reports the correlation matrix of these series and indicates that GHD series for Savoy are strongly correlated with series from Switzerland and French Jura. Savoyard GHD are thus reliable indicators of the summer temperature conditions during the 18th century. In Figures 9 and 10, I show the scatter plot of my temperature variable against the GHD : the higher the temperature anomalies, the warmer the temperature during the summer, and the earlier the harvest of grapes. Overall, these results suggest that temperature variables derived from paleoclimatological data are a reliable estimate of past weather conditions.

I also construct two additional measures of weather shocks to capture only extreme events. I create a dummy variable, *Droughts*, equal one if the seasonal temperature deviation is at least one standard deviation larger than the long-term mean, and zero otherwise. Similarly, to capture extremely wet seasons during which floods were more likely, I create a dummy variable, *Floods*, equal one if the seasonal precipitation deviation is at least one standard deviation larger than the long-term mean, and zero otherwise.

3.3 Socio-economic data

Prices data. Baud (2010) and Viallet (1993) suggest that the impact of crop prices on real income was more important for urban dwellers and landless rural labourers than for farmers. Large unexpected variations in prices, however, also affected farmers who needed to buy livestock fodder, in particular after a bad harvest. I collect data on wheat prices in early October, right after the harvests, on the markets of Annecy and Chambéry to approximate annual changes in living standards (Figure 12).[58] In Table 12, I show the correlation between wheat prices and the standardised temperature deviation during summer in the province of Genevois and Savoie. Warmer temperature are positively correlated with higher wheat prices, supporting the idea that temperature shocks often resulted in negative transitory economic shocks that could, in turn, influence the incidence of crime.

Mehlum, Miguel and Torvik (2006) argue that higher rye prices were concomitant with higher beer prices, leading to less alcohol consumption, and reducing the incidence of violent

[58] For Annecy, monthly average of wheat prices on the four markets of October. Archives Municipales (hereafter A.M.) Annecy, HH2, Mercuriales 1629–1789. For Chambéry, wheat prices on 29 September (Saint-Michel). A.M. Chambéry, 189E-Dépôt 1265 – 1294, Registre de la Grenette.

conflicts. Every year, in early December, the city council of Annecy would set the price of a jug of locally produced wine, based on information it gathered about the outcome of the grape harvest.[59] I collect these prices from the registers of deliberations of the city council of Annecy to investigate the effect of temperature shocks on the price of wine. Table 13 reports the correlation between summer temperature shocks in the province of Genevois and the price of red wine in Annecy, and shows that warmer temperatures had a negative effect on the level of wine prices. This result is consistent with the fact that warmer temperatures foster the development of grape and positively affect wine grape harvests, as reflected by earlier GHD. However, the share of wine in the consumption basket is relatively small compared to crops, so that the overall effect of temperature shocks on living standards was likely negative.

Migration data. I collect data on the average rate of seasonal migration at the province level from Becchia et al. (2012). During the 18th century, the administration also carried out, for military purposes, enquiries regarding the number of males aged over 13 in every parish. A few of these documents (*consigne des mâles*) survived for the years 1726, 1758 and 1776. For each individual, they recorded information on the name, the age, the occupation, and the place of living (including if the individual was living abroad).[60] Migration estimates are derived from these documents. These estimates are consistent with estimations from other sources including enquiries carried out by the administration to evaluate the magnitude of migration across several towns in Savoy (Depoisier, 1858; Guichonnet, 1945; Letonnelier, 1920). A potential concern is that the level of seasonal migration varied from one year to another across provinces depending, among other things, on the local economic conditions. Historical evidence, however, show that seasonal migration patterns were quite stable over time.[61]

4 Empirical strategy and results

4.1 Property crime and violent crime

I begin by examining whether changes in year-on-year seasonal temperature influence the property crime rates and violent crime rates in Savoy from spring 1749 to spring 1789. I estimate a reduced-form model of the form:

[59] A.M. Annecy, BB 45 – 55, Registre des délibérations de la ville d'Annecy.

[60] Surprisingly, there is very little difference in numeracy– measured through age-heaping– between the offenders and the victims, as well as across the provinces. The only significant trend is the overall increase in the level of numeracy during the 18th century.

[61] I discuss this issue in more details in Section 4.2.

$$Crime_{ist} = \beta_1 \, Temperature_{its} + \beta_2 \, Temperature_{ist} \times Migration_i + \delta_i + \delta_t + \epsilon_{ist} \tag{1}$$

where $Crime_{its}$ is the log of the *Total crime* rate in province i in season s in year t. Accordingly, *Property crime*, *Violent crime*, and *Theft of edible products* denote the log of the crime rate for each category of criminal offence.[62] $Temperature_{its}$ is the seasonal standardised temperature deviation from the long-term mean (1500–1600) in province i during season s in year t.[63] $Migration_i$ is (i) a dummy variable equal to one if the seasonal migration rate in province i is higher than the mean migration rate in the duchy of Savoy, and zero otherwise (intensive margins); (ii) a continuous variables equal to the seasonal migration rate in province i (extensive margins). δ_i are province fixed effects that account for time-invariant province characteristics, such as altitude, land characteristics, and distance to markets. δ_t are year fixed effects, and account for time-variant characteristics that may affect all provinces at the same time. Standard errors are clustered at the provincial level. Given that my data set includes only six provinces, I estimate the p-value of the coefficients of interest from the wild cluster bootstrap-t procedure (Cameron, Gelbach and Miller, 2008). The β_1-coefficient captures the effect of temperature shocks on the incidence of crimes, whereas the β_2-coefficient indicates the differential effect between provinces with high migration rates, and provinces with low rates.

To identify the effect of temperature shocks on crime rates, I begin by estimating Equation 1 without the interaction term. Table 3 reports the main results. In column 1, I report the estimate from pooling together all crime categories in a single category, *Total crime*. The estimated coefficient is statistically non-significant, which is not surprising given that theory suggests that temperature shocks may have opposite effect on the violent crimes rates and property crimes rates. Column 2 reports the coefficient of the effect of *Temperature* on violent crimes rates. The coefficient is negative and statistically significant, indicating that there were significantly less violent crimes during economic downturns. Previous empirical studies suggest that transitory poverty shocks temporarily reduced the level of alcohol consumption, which in turn reduces the frequency of violent crimes. In previous section, I showed that warmer temperature was correlated with lower wine prices and led to a positive income effect. However, warmer temperature was also correlated with higher wheat prices leading individuals to spend a higher share of their total income on staple crops rather than alcohol

[62] Crime rate is calculated as the ratio of offenders per 100,000 inhabitants (see Section 3.1 for more details).
[63] See Section 3.2.

consumption (substitution effect). Besides, the increases in crop prices affected all members of the household, whereas the decline in wine prices affected at most two members of the household. That means that the welfare gain (income effect) was likely to be smaller than the welfare loss (substitution effect) induces by increases in crop prices. Overall, the reduced-form effect of temperature shock on violent crimes was negative in 18th-century Savoy.[64] Results presented in column 3 suggest that warmer temperature had a positive and statistically significant effect on property crimes rates. A one standard deviation increases in temperature increased the incidence of property crimes by 3.5%.[65] Adverse weather conditions reduced prospects of the next harvest and increased pressure on current prices. This in turn created situation of economic stress for more vulnerable individuals.[66] This is consistent with the fact that weather-induced economic shocks were a source of economic deprivation that led some individuals to commit crimes to survive (Bignon, Caroli and Galbiati, 2017; Mehlum, Miguel and Torvik, 2006).

Robustness checks. In this subsection, I present a variety of robustness exercises that support the interpretation of my findings. I show that my baseline estimates are neither subjected to an omitted variables bias (Table 4) nor dependent on my definition of temperature shocks (Table 5). Table 6 reports the estimates from Equation 1 when seasonal lags are added as independent variables. Past climatic conditions have no significant impact on violent crime rates and property crime rates.[67] Finally, I restrict my attention to most extreme events– *Drougths* and *Floods*. Table 7 reports the estimated effects of seasonal *Droughts* and seasonal *Floods* on violent crime and property crime rates. The signs of the coefficient estimates are in line with my baseline estimates. However, magnitudes are larger suggesting that more extreme weather shocks had stronger negative impact on local economic conditions leaving

[64] It should be noted, however, that the worst shocks, i.e. those associated with famine, could result in an increase in violent crime. See for instance (Alfani, 2011, pp. 30–1).

[65] Blakeslee and Fishman (2018) find an effect of similar magnitude in contemporary India.

[66] For more details about this mechanism, see Labrousse (1933), Goubert (1960), and Nicolas (1978).

[67] In column 6, the coefficient for the *Temperature* is positive but non-significant at the conventional level. Interestingly, the coefficient of *Temperature s-2* is negative, though not statistically significant, suggesting that temperature shocks that occurred half a year earlier had a negative impact on the current level of property crimes. One plausible explanation is that if province experience successively adverse weather conditions, local and state authorities were able to intervene and provide sufficient relief to mitigate the negative effect of temperature shock, reducing the expected benefit derived from perpetrating crime against property and thus making it unnecessary. In Appendix A.1, I provide detailed information on the system of poor relief and document how authorities successfully prevented dearth after the occurrence of bad harvests. The development of bureaucratisation under the aegis of intendants during the first half of the 18th century, and the implementation of a stable monitoring system of local socio-economic conditions make it possible to grant adequate tax exemption and to distribute seeds and grains when it was required. That in turn significantly improves the resilience of local communities against negative transitory economic shocks.

more households in situation of economic stress.

4.2 The role of seasonal migration

Was seasonal migration an efficient buffer against weather shocks? In Section 2.4, I provide historical evidence to argue that seasonal migration could contribute to the mitigation of weather shocks through two channels: remittances and reduction of the Malthusian constraints. To investigate this question, I analyse whether temperature shocks affect crime rates differentially in provinces in which average seasonal migration rate was high (Equation 1).

Coefficient estimates for the intensive margins are presented in Table 8. In Section 2.4, I provide narrative evidence to show that remittances derived from migrant labour made the former provinces relatively better-off. In column 3, the positive coefficient on *Temperature* indicates that warmer temperature significantly increases the level of property crimes. The negative coefficient on *Temperature* $\times$ *Migration* (β_2) is negative and statistically significant. Hence, when adverse weather conditions occurred, province that had structurally higher level of seasonal migration witnessed less crimes against property than other provinces. It is, however, impossible to identify the exact underlying mechanism. Migrant labour also meant that a significant share of the young able-bodied men, the bulk of criminals in the 18th-century Europe (Lecoutre, 2010), was temporarily out of the province. Thus, the effect may also be driven by the fact that provinces with higher seasonal migration rate faced temporarily lower population pressure and/or were temporarily discharged from some of its most criminogenic population.[68] That would be consistent with the fact that seasonal migration did not mitigate the effect of temperature shocks on violent crimes. If as suggested in previous empirical studies, the decline in violent crimes is driven by a relative decline in purchasing power, then I should expect the coefficient *Temperature* $\times$ *Migration* to be positive in column 2. That it is negative indicates that the effect of welfare gains linked to seasonal migration was smaller than the effect of a temporary reduction in the criminogenic population. Focusing on the extensive effect of seasonal migration leaves the results unchanged (Table 8, columns 2 and 3). Table 10 reports the effect of temperature shocks and migration on a subset of violent crimes: physical violences committed against individuals but excluding homicide. The results are in line with the previous findings and suggest that seasonal migration had no significant effect on the level of violence. My quantitative analysis thus confirms my conclusions drawn from reading historiographical literature and archival sources.

[68] Castan (1977) finds that women represented about 20 per cent of the offenders behind property crimes in 18th century Provence.

In Table 11, I present estimates of the effect of temperature shocks on the rate of property crimes that involved the theft of edible products. This specific type of property crime can be more directly related to hunger, and may, in turn, provide additional evidence on the underlying mechanism at stake in the relationship described above. Columns 1 to 3 reports the result estimating Equation 1 without the interaction term. Columns reports estimated coefficients of the intensive and extensive effect of seasonal migration (from Equation 1). In all columns, the coefficient on *Temperature* is positive and statistically significant, suggesting that temperature shocks had strong impact on the level of property crimes rates that involved the theft of edible products. This result confirms the idea that economic deprivation might have been one of the main factors behind the increase of property crime rates, when provinces were hit by adverse weather conditions. When I examine the effect of seasonal migration, I find results that are qualitatively similar to my baseline findings (see Table 8 and Table 9). In provinces with higher shares of migrant labour, migration allowed for an inflow of remittances as well as a temporary escape from the Malthusian pressure, significantly improving the life of individuals who did not migrate, and providing them with better capabilities to cope with transitory economic shocks. This may, in turn, have decreased the necessity of stealing to survive. Given the limitations behind the construction of the variable on the theft of edible products (see Section 3.3), this evidence is merely suggestive, but in line with previous empirical evidence in the literature (Axbard, 2016; Bignon, Caroli and Galbiati, 2017).

The level of seasonal migration varied from one year to another across provinces depending, among other things, on the local economic conditions. One concern is that using the average rate of migration at the provincial level may fail to capture changes in the intensity of migration and/or changes in the geographical pattern of migrations. If the migration rate was higher than the average during economic downturns, then its potential mitigating effect on crime rates may be over-estimated. Conversely, its effect could be under-estimated during non-crisis year, leaving the overall direction of the bias undetermined. Another concern is that the relative importance of migration across provinces changes over time due to variations in the timing of exposure to strong weather shocks. Two factors assuage the concern described above. First, the most important weather shocks were of regional, if not continental, dimension during the second half of the 18th century. This means, in turn, that all provinces were badly affected at the same time by the worst weather shocks in 1772 and 1779. Second, historians have shown that the pattern of seasonal migration is highly persistent over time because it required structured (village) networks and some sorts of specialised knowledge (Bruchet, 1897; Guichonnet, 1945; Letonnelier, 1920; Siddle, 1997). Migrants from one village often migrated to

the same area every year and specialised in one of the following occupations: mason, charcoal burner, pedlar, or agricultural worker. Therefore, it is unlikely that a negative transitory shock completely shook up the structural differences across provinces in seasonal migration movements.

5 Conclusion

Research questions raised in this paper were motivated by a recent trend in the literature that has consistently demonstrated the existence of a significant relationship between weather variations, economic shocks, and interpersonal conflicts. I link temperature data with economic variables and crime data to examine the effect of temperature shocks in the context of early modern Savoy. I investigate the role of seasonal migration, and try to ascertain whether it was effective in alleviating the effect of negative economic shocks. Overall, I show that temperature shocks had a positive and significant effect on property crimes rates and a strong negative impact on violent crimes rates. Previous findings in the literature also suggest that there is a positive relationship between alcohol consumption and violence. I show that temperature shocks were associated with lower wine prices in the province of Genevois, but the net welfare effect of temperature was negative given the relative share of crops in the household consumption basket. Additionally, I provide qualitative and quantitative evidence suggesting that seasonal migration weakened the link between temperature shocks and property crimes. Together with poor relief and state interventions, seasonal migration may have also helped local communities to build higher resilience against weather shocks and sustain population growth during the 18th century.

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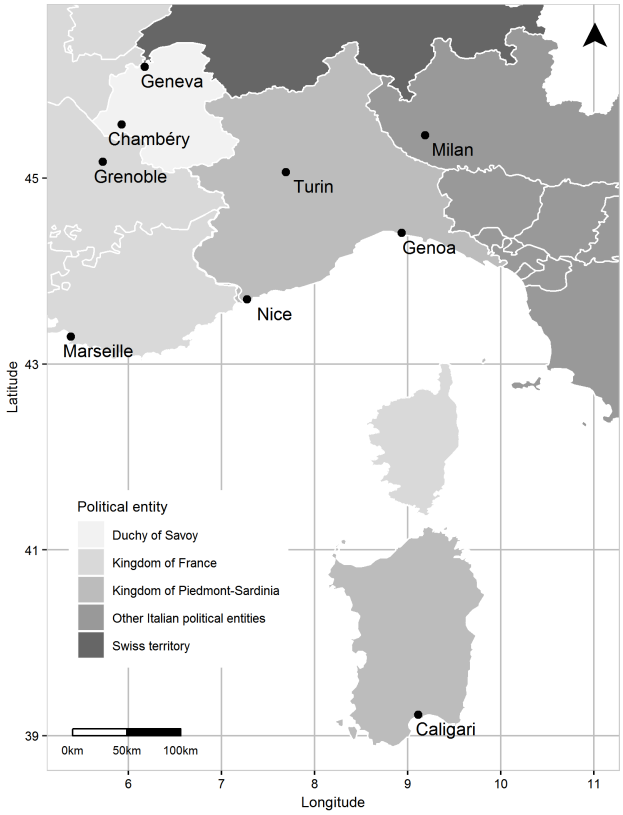


Figure 1: The Kingdom of Piedmont-Sardinia (c. 1780)

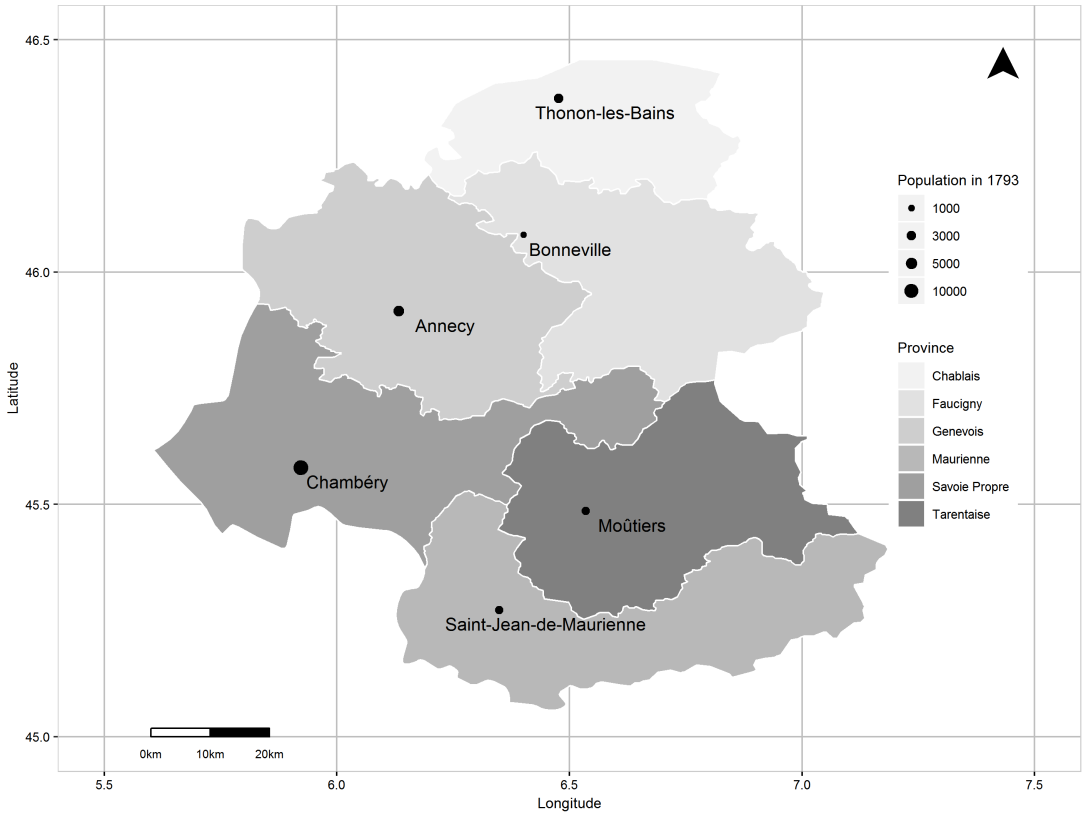
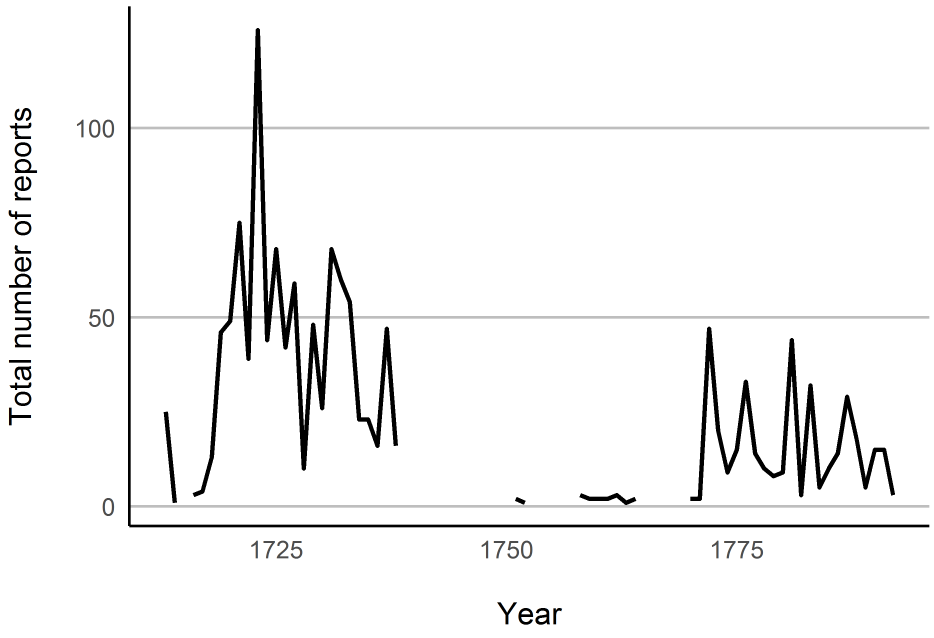
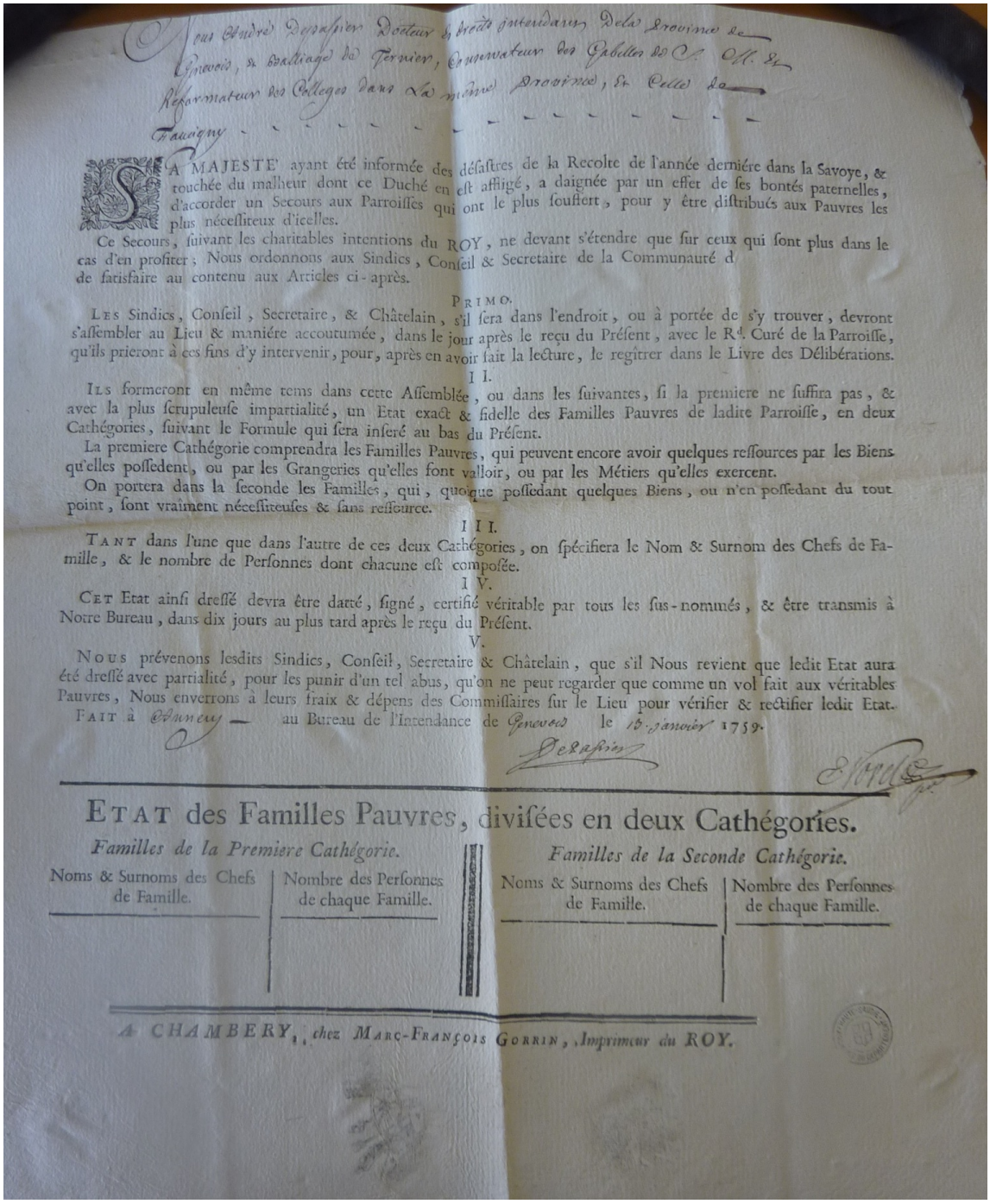


Figure 2: The Duchy of Savoy (c. 1750)



Sources: A.D. Savoie, SA 5420 – 5482.

Figure 3: Annual number of disasters reported in the Duchy of Savoy (1713–92)



Nous Claude Desarsiers Docteur ès droits Intendant Delà Province de Genevois, & Baillage de Gex, Conservateur des Gabelles de Ll. Ol. & Réformateur des Colleges dans la même Province, & Celle de Faucigny . . . . . .

SA MAJESTE' ayant été informée des désastres de la Recolte de l'année dernière dans la Savoye, & touchée du malheur dont ce Duché en est affligé, a daignée par un effet de ses bontés paternelles, d'accorder un Secours aux Parroisses qui ont le plus souffert, pour y être distribués aux Pauvres les plus nécessiteux d'icelles.

Ce Secours, suivant les charitables intentions du ROY, ne devant s'étendre que sur ceux qui sont plus dans le cas d'en profiter; Nous ordonnons aux Sindics, Conseil & Secretaire de la Communauté d de satisfaire au contenu aux Articles ci-après.

PRIMO.

LES Sindics, Conseil, Secretaire, & Châtelain, s'il sera dans l'endroit, ou à portée de s'y trouver, devront s'assembler au Lieu & maniére accoutumée, dans le jour après le reçu du Présent, avec le R.d. Curé de la Parroisse, qu'ils prieront à ces fins d'y intervenir, pour, après en avoir fait la lecture, le regitrer dans le Livre des Délibérations.

II.

ILS formeront en même tems dans cette Assemblée, ou dans les suivantes, si la premiere ne suffira pas, & avec la plus scrupuleuse impartialité, un Etat exact & fidelle des Familles Pauvres de ladite Parroisse, en deux Cathégories, suivant le Formule qui sera inseré au bas du Présent.

La premiere Cathégorie comprendra les Familles Pauvres, qui peuvent encore avoir quelques ressources par les Biens qu'elles possedent, ou par les Grangeries qu'elles font valloir, ou par les Métiers qu'elles exercent.

On portera dans la seconde les Familles, qui, quoique possedant quelques Biens, ou n'en possedant du tout point, sont vraiment nécessiteuses & sans ressource.

III.

TANT dans l'une que dans l'autre de ces deux Cathégories, on spécifiera le Nom & Surnom des Chefs de Famille, & le nombre de Personnes dont chacune est composée.

IV.

CET Etat ainsi dressé devra être datté, signé, certifié véritable par tous les sus-nommés, & être transmis à Notre Bureau, dans dix jours au plus tard après le reçu du Présent.

V.

NOUS prévenons lesdits Sindics, Conseil, Secretaire & Châtelain, que s'il Nous revient que ledit Etat aura été dressé avec partialité, pour les punir d'un tel abus, qu'on ne peut regarder que comme un vol fait aux véritables Pauvres, Nous enverrons à leurs fraix & dépens des Commissaires sur le Lieu pour vérifier & rectifier ledit Etat.

FAIT à Annecy — au Bureau de l'Intendance de Genevois le 16. janvier 1759.

Desarsiers

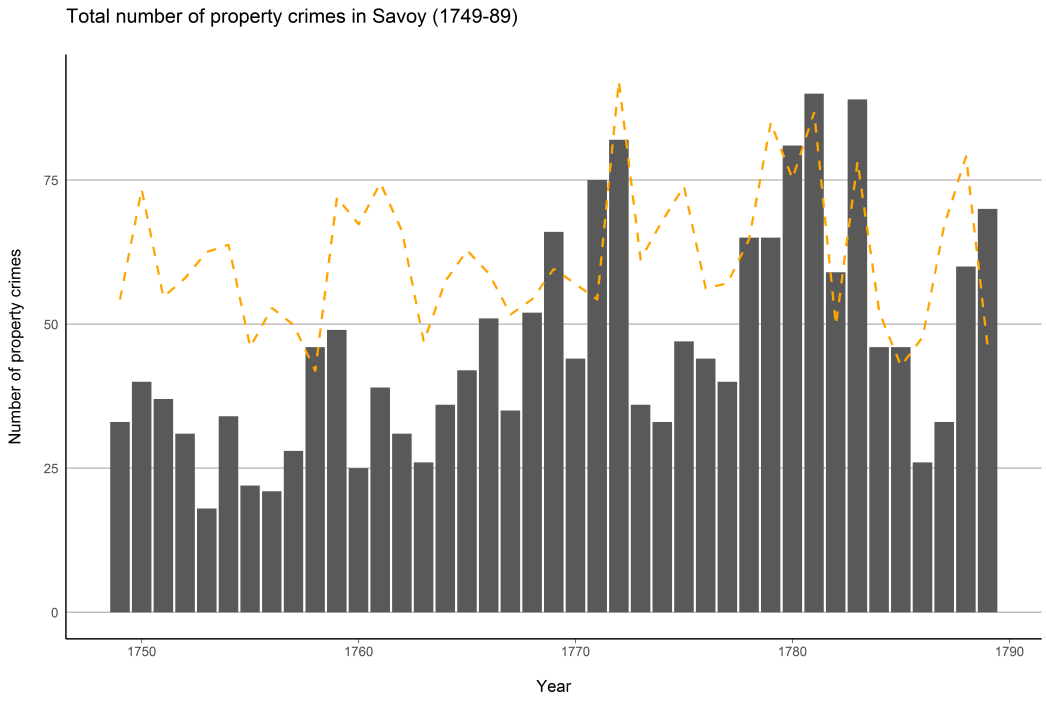
ETAT des Familles Pauvres, divisées en deux Cathégories.

Familles de la Premiere Cathégorie.		*Familles de la Seconde Cathégorie.*	
Noms & Surnoms des Chefs de Famille.	Nombre des Personnes de chaque Famille.	Noms & Surnoms des Chefs de Famille.	Nombre des Personnes de chaque Famille.

A CHAMBERY, chez MARC-FRANÇOIS GORRIN, Imprimeur du ROY.

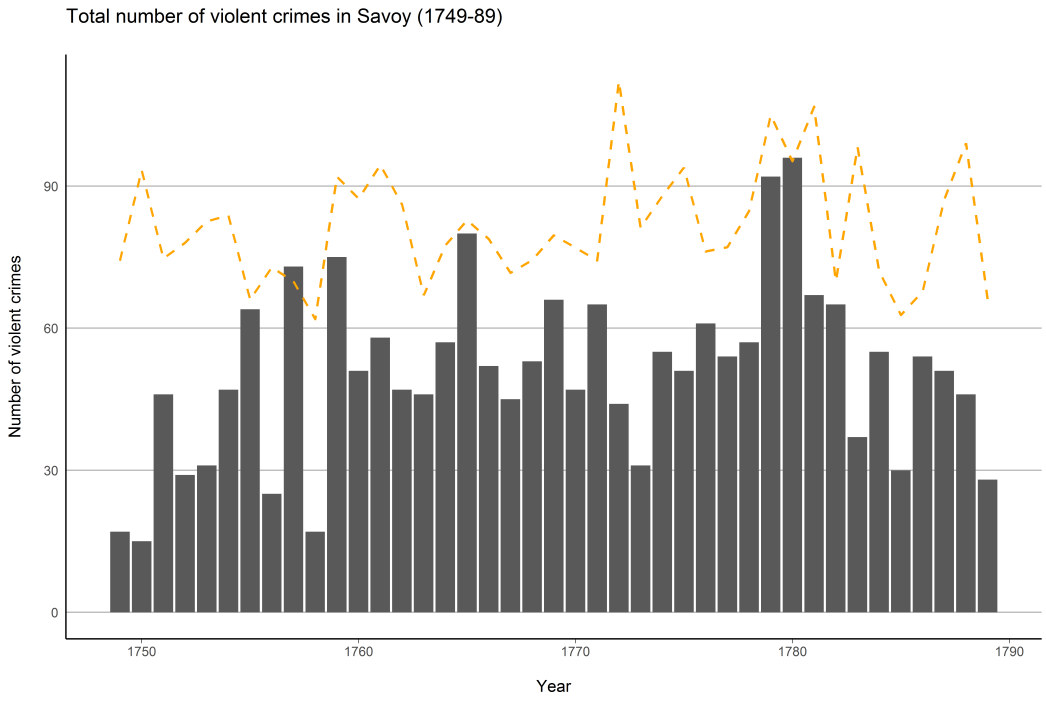
Sources: A.D. Haute-Savoie, C 4 178.

Figure 4: Official query regarding the situation of the poor in Savoy in January 1759



Notes: The dashed lined represented the sum of the seasonal temperature anomalies in Savoyard provinces in any given year. A value close to zero means that weather conditions were closed to the long-term mean. To improve readability, I translate all annual values by adding 60. The higher the dashed line, the warmer the year.

Figure 5: Total number of property crimes in Savoy (1749–89)



Notes: The dashed lined represented the sum of the seasonal temperature anomalies in Savoyard provinces in any given year. A value close to zero means that weather conditions were closed to the long-term mean. To improve readability, I translate all annual values by adding 80. The higher the dashed line, the warmer the year.

Figure 6: Total number of violent crimes in Savoy (1749–89)

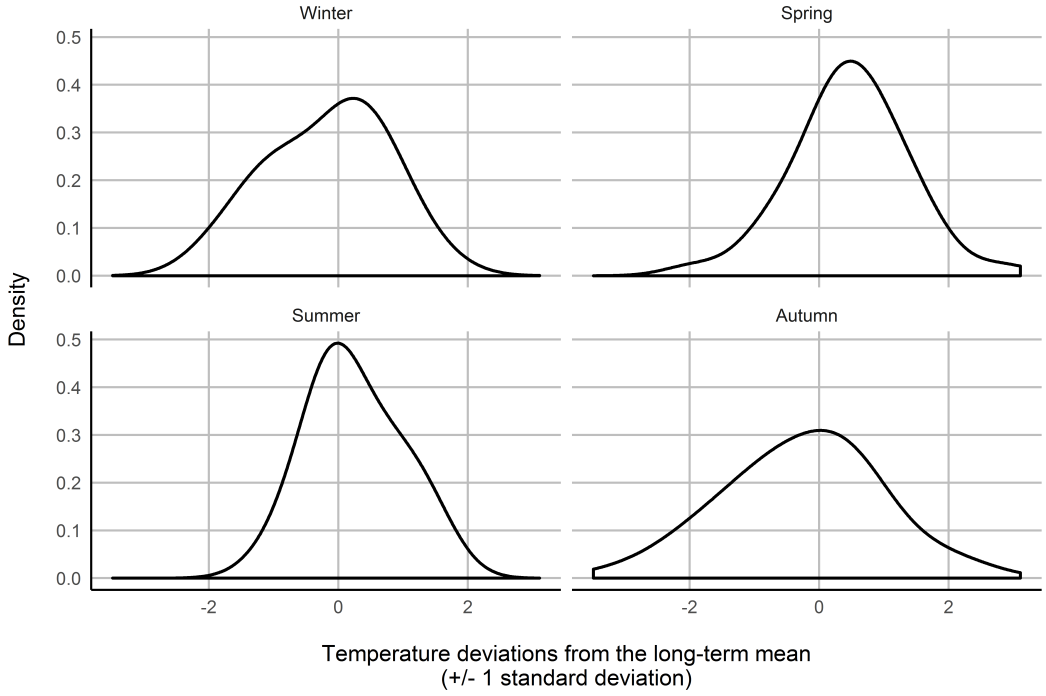


Figure 7: Distribution of seasonal temperature (1749–89)

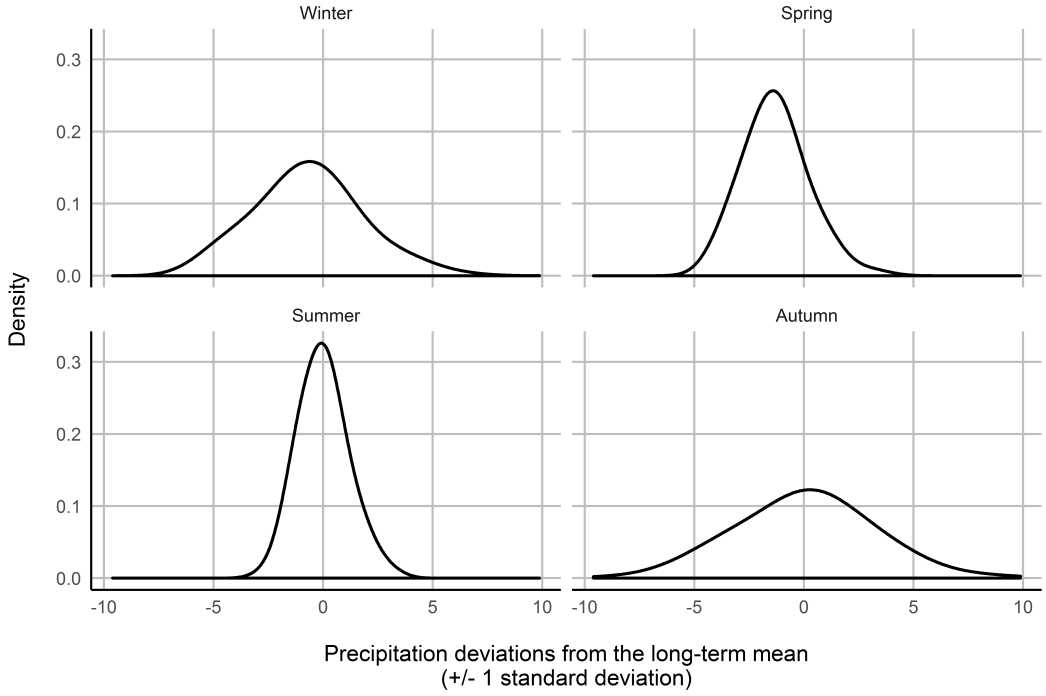


Figure 8: Distribution of seasonal precipitation (1749–89)

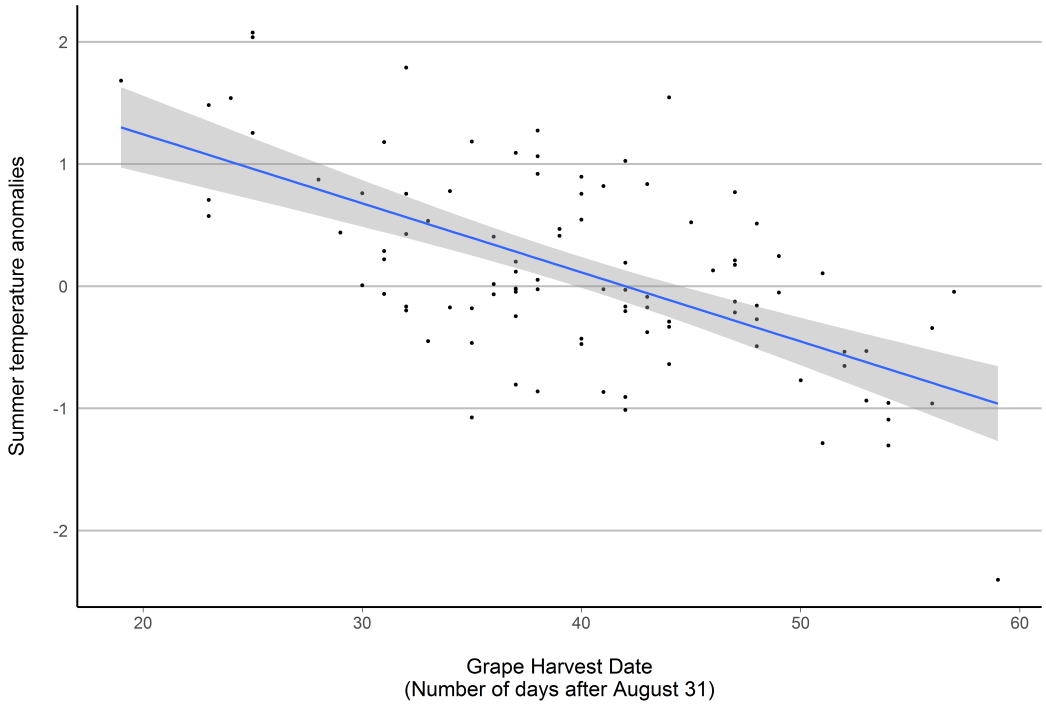


Figure 9: Grape harvest date and summer temperature in Chablais (1688–1794)

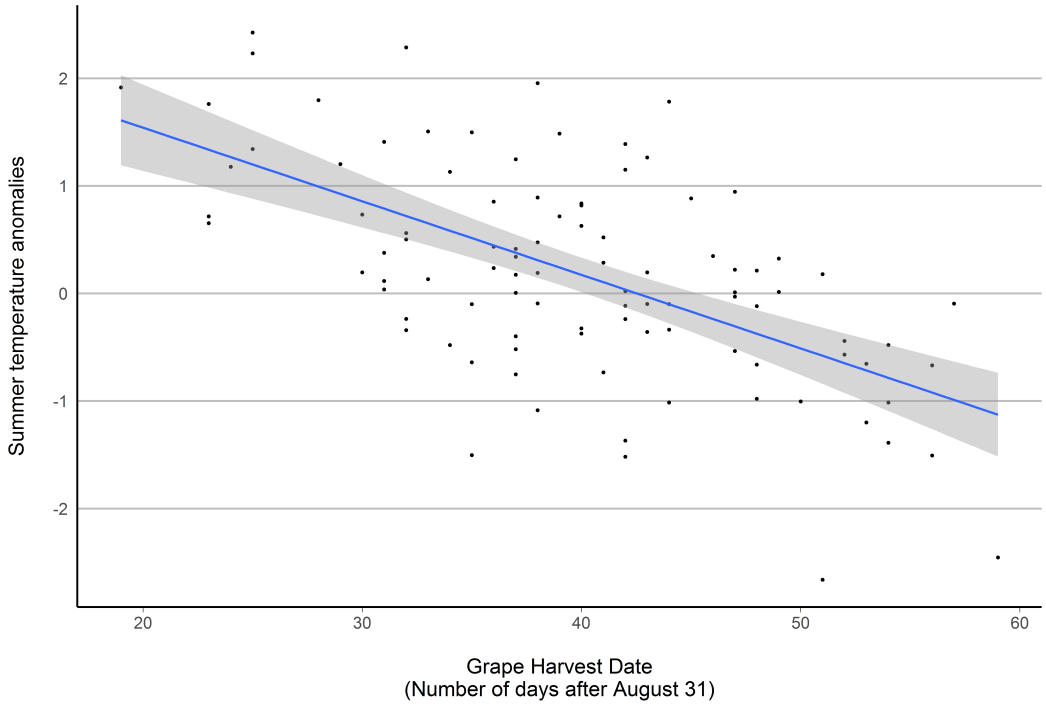


Figure 10: Grape harvest date and summer temperature in Maurienne (1713–90)

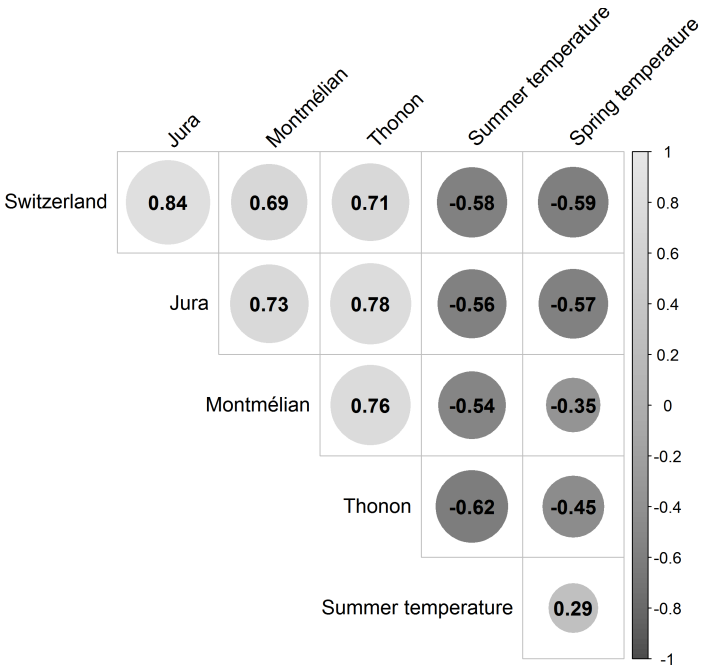


Figure 11: Correlation matrix of grape harvest date around the Alpine Arc (1688–1794)

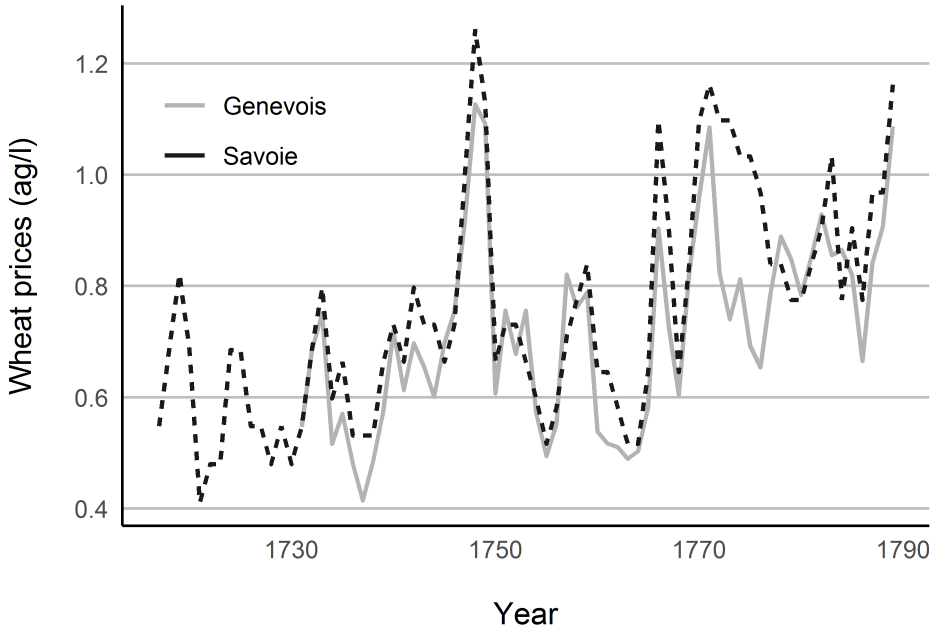


Figure 12: Wheat prices in the provinces of Genevois and Savoie (1717–89)

Table 1: Subsistence lifestyle: Baskets of goods in Savoy (c.1780)

	Quantity per year	Unit	Kcal/unit	Nutriments per day	
				Kcal/day	Grams of Protein
Bread	580	kg	2,000	3,200	80
Bean	20	kg	1,100	60	4
Meat	20	kg	2000	110	11
Butter	6	kg	7,500	123	0
Cheese	10	kg	3,700	106	6
Wine	150	l	700	288	0
Total				3,887	101

Sources: Allen et al. (2011); Becchia et al. (2012); Malanima (2013); Nicolas (1979); Vermale (1911).

Table 2: Summary statistics

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
Crime data							
Crime rate per 100,000	966	7.07	8.39	0	1.2	10.0	84
Violent crime rate per 100,000	966	3.81	6.00	0	0	5.6	72
Property crime rate per 100,000	966	3.27	4.85	-1	0	5.0	70
Weather data							
Temperarature anomalies	966	0.08	0.97	-3.49	-0.53	0.72	3.11
Precipitation anomalies	966	-0.49	2.19	-9.61	-1.72	0.67	9.88
Temperarature (°C)	966	5.80	5.97	-5.70	1.13	9.73	17.30
Precipitation (mm)	966	313.15	112.39	32	238.2	392	614
Grape harvest date	174	43	8	19	37.2	49	59
Socio-economic data							
Seasonal migration rate	6	0.090	0.046	0.036	0.059	0.121	0.155
Number of cattle per head	6	0.628	0.095	0.539	0.571	0.660	0.797
Prices data							
Annecy wheat prices (ag/l)	59	0.73	0.17	0.41	0.58	0.83	1.13
Chambéry wheat prices (ag/l)	73	0.75	0.20	0.41	0.60	0.84	1.26
Annecy red wine prices (ag/l)	49	1.26	0.39	0.69	1.06	1.37	2.39
Population data							
Population in 1758	6	48,421	25,318	26,999	31,008	57,990.5	92,868
Population in 1776	6	57,636	33,052	31,687	34,695.2	67,837.8	117,263
Population in 1793	6	66,582	38,287	37,863	41,386	76,471	136,988

Notes: Grape harvest date is expressed as the number of days after the 31 August.

Table 3: Temperature shocks and crime rates in Savoy (1749–89)

	Total crime	Violent crime	Property crime
	(1)	(2)	(3)
Temperature	−0.030	−0.082***	0.035*
	(0.024)	(0.028)	(0.020)
Province FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	966	966	966

Notes: Significant at ***1%, **5%, *10%. Panel linear estimations with province fixed effects and year fixed effects. Cluster bootstrapped standard errors in parentheses (Cameron et al., 2008).
In column 1, the dependent variable is the log of total number of crimes per 100,000 inhabitants in province i during season s in year t. In columns 2 to 3, the dependent variables are defined accordingly for violent crimes, and property crimes. The independent variable Temperature is the seasonal temperature deviation from the long-term seasonal mean (1500–1600) in province i, divided by its standard deviation. Province FE is a full set of province fixed effects. Year FE is a full set of year fixed effects.

Table 4: Robustness checks: Inclusion of additional weather variables

	Total crime		Violent crime		Property crime	
	(1)	(2)	(3)	(4)	(5)	(6)
Temperature	−0.023	−0.027	−0.087***	−0.081***	0.047*	0.039*
	(0.023)	(0.024)	(0.027)	(0.027)	(0.025)	(0.023)
Temperature^2	0.027		−0.019		0.046**	
	(0.021)		(0.015)		(0.021)	
Precipitation		0.016		0.004		0.022
		(0.017)		(0.019)		(0.016)
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	966	966	966	966	966	966

Notes: Significant at ***1%, **5%, *10%. Panel linear estimations with province fixed effects and year fixed effects. Cluster bootstrapped standard errors in parentheses (Cameron et al., 2008).
In columns 1 and 2, the dependent variable is the log of total number of crimes per 100,000 inhabitants in province i during season s in year t. In Columns 3 to 6, the dependent variables are defined accordingly for violent crimes, and property crimes. The independent variable Temperature is the seasonal temperature deviation from the long-term seasonal mean (1500–1600) in province i, divided by its standard deviation. The other independant variables are defined accordingly. Province FE is a full set of province fixed effects. Year FE is a full set of year fixed effects.

Table 5: Robustness checks: Alternative measures of temperature

	Total crime		Violent crime		Property crime	
	(1)	(2)	(3)	(4)	(5)	(6)
Temperature 50 MA	-0.035^{*}		-0.086^{***}		0.034^{*}	
	(0.020)		(0.031)		(0.020)	
Temperature level		-0.006^{*}		-0.010^{**}		0.004
		(0.003)		(0.004)		(0.004)
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	966	966	966	966	966	966

Notes: Significant at ***1%, **5%, *10%. Panel linear estimations with province fixed effects and year fixed effects. Cluster bootstrapped standard errors in parentheses (Cameron et al., 2008). In columns 1 and 2, the dependent variable is the log of total number of crimes per 100,000 inhabitants in province i during season s in year t. In Columns 3 to 6, the dependent variables are defined accordingly for violent crimes, and property crimes. The independent variable Temperature 50 MA is the seasonal temperature deviation from the 50 years moving average in province i, divided by its standard deviation. Temperature level is the average temperature in province i during season s in year t. Province FE is a full set of province fixed effects. Year FE is a full set of year fixed effects.

Table 6: Robustness checks: Alternative measures of temperature

	Total crime		Violent crime		Property crime	
	(1)	(2)	(3)	(4)	(5)	(6)
Temperature	-0.028	-0.040	-0.089^{***}	-0.093^{**}	0.044^{**}	0.034
	(0.027)	(0.027)	(0.034)	(0.036)	(0.019)	(0.022)
Temperature *s-1*	0.006	-0.005	-0.030	-0.034	0.037	0.027
	(0.020)	(0.026)	(0.038)	(0.041)	(0.027)	(0.035)
Temperature *s-2*		-0.033		-0.011		-0.029
		(0.029)		(0.029)		(0.035)
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	966	966	966	966	966	966

Notes: Significant at ***1%, **5%, *10%. Panel linear estimations with province fixed effects and year fixed effects. Cluster bootstrapped standard errors in parentheses (Cameron et al., 2008).
In columns 1 and 2, the dependent variable is the log of total number of crimes per 100,000 inhabitants in province i during season s in year t. In Columns 3 to 6, the dependent variables are defined accordingly for violent crimes, and property crimes. The independent variable Temperature is the seasonal temperature deviation from the long-term seasonal mean (1500–1600) in province i, divided by its standard deviation. Province FE is a full set of province fixed effects. Year FE is a full set of year fixed effects.

Table 7: Robustness checks: Droughts, floods and crime rate in Savoy (1749–89)

	Total crime	Violent crime	Property crime
	(1)	(2)	(3)
Droughts	0.088***	−0.138***	0.246***
	(0.032)	(0.046)	(0.061)
Floods	0.021	−0.001	0.078**
	(0.066)	(0.078)	(0.037)
Province FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	966	966	966

Notes: Significant at ***1%, **5%, *10%. Panel linear estimations with province fixed effects and year fixed effects. Cluster bootstrapped standard errors in parentheses (Cameron et al., 2008).
In column 1, the dependent variable is the log of total number of crimes per 100,000 inhabitants in province i during season s in year t. In columns 2 to 3, the dependent variables are defined accordingly for violent crimes, and property crimes. The independent variable Droughts is a dummy variable equal to one if seasonal temperature in province i is one standard deviation or more above the long-term seasonal mean (1500–1600), and zero otherwise. The independent variable Floods is a dummy variable equal to one if seasonal precipitation in province i is one standard deviation or more above the long-term seasonal mean (1500–1600), and zero otherwise. Province FE is a full set of province fixed effects. Year FE is a full set of year fixed effects.

Table 8: The effect of seasonal migration: Intensive margins

	Total crime	Violent crime	Property crime
	(1)	(2)	(3)
Temperature	−0.002	−0.069*	0.066***
	(0.025)	(0.035)	(0.014)
Temperature × Migration	−0.084**	−0.039	−0.094**
	(0.036)	(0.060)	(0.045)
Province FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	966	966	966

Notes: Significant at ***1%, **5%, *10%. Panel linear estimations with province fixed effects and year fixed effects. Cluster bootstrapped standard errors in parentheses (Cameron et al., 2008).
In column 1, the dependent variable is the log of total number of crimes per 100,000 inhabitants in province i during season s in year t. In columns 2 to 3, the dependent variables are defined accordingly for violent crimes, and property crimes. The independent variable Temperature is the seasonal temperature deviation from the long-term seasonal mean (1500–1600) in province i, divided by its standard deviation. Migration is a dummy variable equal to one if the average seasonal migration rate in province i is above the Savoyard mean, and zero otherwise. Province FE is a full set of province fixed effects. Year FE is a full set of year fixed effects.

Table 9: The effect of seasonal migration: Extensive margins

	Total crime	Violent crime	Property crime
	(1)	(2)	(3)
Temperature	0.014	-0.095^{**}	0.104^{***}
	(0.033)	(0.041)	(0.038)
Temperature × Migration	-0.005	0.001	-0.008^{**}
	(0.003)	(0.005)	(0.004)
Province FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	966	966	966

Notes: Significant at ***1%, **5%, *10%. Panel linear estimations with province fixed effects and year fixed effects. Cluster bootstrapped standard errors in parentheses (Cameron et al., 2008). In column 1, the dependent variable is the log of total number of crimes per 100,000 inhabitants in province i during season s in year t. In columns 2 to 3, the dependent variables are defined accordingly for violent crimes, and property crimes. The independent variable Temperature is the seasonal temperature deviation from the long-term seasonal mean (1500–1600) in province i, divided by its standard deviation. Migration is a continuous variable equal to the rate of seasonal migration in province i. Province FE is a full set of province fixed effects. Year FE is a full set of year fixed effects.

Table 10: Mitigation of physical violence against persons

	Physical violence against persons		
	(1)	(2)	(3)
Temperature	-0.075^{**}	-0.063^{**}	-0.084^{**}
	(0.038)	(0.025)	(0.043)
Temperature		-0.036	
× Migration intensive		(0.081)	
Temperature			0.001
× Migration extensive			(0.007)
Province FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	966	966	966

Notes: Significant at ***1%, **5%, *10%. Panel linear estimations with province fixed effects and year fixed effects. Cluster bootstrapped standard errors in parentheses (Cameron et al., 2008). The dependent variable is the log of total number of physical violence against persons (exlcuding homicide) per 100,000 inhabitants in province i during season s in year t. The independent variable Temperature is the seasonal temperature deviation from the long-term seasonal mean (1500–1600) in province i, divided by its standard deviation. Migration intensive is a dummy variable equal to one if the average seasonal migration rate in province i is above the Savoyard mean, and zero otherwise. Migration extensive is a continuous variable equal to the rate of seasonal migration in province i. Province FE is a full set of province fixed effects. Year FE is a full set of year fixed effects.

Table 11: Mitigation of thefts of edible products

	Thefts of edible products		
	(1)	(2)	(3)
Temperature	0.040**	0.055***	0.101***
	(0.016)	(0.012)	(0.013)
Temperature		−0.044	
× Migration intensive		(0.030)	
Temperature			−0.007***
× Migration extensive			(0.002)
Province FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	966	966	966

Notes: Significant at ***1%, **5%, *10%. Panel linear estimations with province fixed effects and year fixed effects. Cluster bootstrapped standard errors in parentheses (Cameron et al., 2008).
The dependent variable is the log of total number of thefts of edible products per 100,000 inhabitants in province *i* during season *s* in year *t*. The independent variable Temperature is the seasonal temperature deviation from the long-term seasonal mean (1500–1600) in province *i*, divided by its standard deviation. Migration intensive is a dummy variable equal to one if the average seasonal migration rate in province *i* is above the Savoyard mean, and zero otherwise. Migration extensive is a continuous variable equal to the rate of seasonal migration in province *i*. Province FE is a full set of province fixed effects. Year FE is a full set of year fixed effects.

Table 12: Temperature shocks and wheat prices in Savoy (1717-89)

	Log of wheat prices (ag/l)			
	(1)	(2)	(3)	(4)
Temperature	0.012	0.026*	0.025*	0.025*
	(0.012)	(0.015)	(0.015)	(0.015)
Temperature *t-1*			0.062***	0.062***
			(0.015)	(0.015)
Province FE	No	No	No	Yes
Observations	132	132	131	131
R^2	0.015	0.042	0.179	0.187

Notes: Significant at ***1%, **5%, *10%. OLS estimations. Robust standard errors in parentheses.
The dependent variable is the log of wheat prices in grams of silver per litre in province *i* during after harvest time (Autumn) in year *t*. The data set covers the provinces of Genevois (1731–89) and Savoie (1717–89). The independent variable Temperature is the summer temperature deviation from the long-term seasonal mean (1500–1600) in province *i*, divided by its standard deviation. The other independant variables are defined accordingly. In columns 2 to 4, summer precipitation anomalies are included as control variables. Province FE is a set of province fixed effects.

Table 13: Temperature shocks and wine prices in Savoy (1741–89)

	Log of wine prices (ag/l)		
	(1)	(2)	(3)
Temperature	-0.082^{**}	-0.083^{**}	-0.078^{*}
	(0.037)	(0.037)	(0.044)
Temperature *t-1*			-0.085^{*}
			(0.045)
Observations	49	49	49
R^2	0.099	0.120	0.276

Notes: Significant at ***1%, **5%, *10%. OLS estimations. Robust standard errors in parentheses.
The dependent variable is the log of red wine prices in grams of silver per litre in the city of Annecy in year *t*. The price is fixed by the city counsil in early December after the end of the grape harvest. The independent variable Temperature is the summer temperature deviation from the long-term seasonal mean (1500–1600) in the province of Genevois, divided by its standard deviation. The other independant variables are defined accordingly. To account for the early growing season, column 2 includes the spring temperature deviation from the long-term seasonal mean (1500–1600) in the province of Genevois, divided by its standard deviation.

Online Appendix

A Other coping mechanisms

A.1 Poverty shocks and public assistance

Throughout the 18th century, no comprehensive system of relieving those in need, like the poor law in England, existed in the duchy Savoy. The Savoyard system relied on state and municipal interventions as well as permanent institutions run thanks to patronage and religious orders. Figure 12 displays price variations of wheat on the markets of Annecy and Chambéry. Because of the importance of staple crops in the average diet, any increase in prices resulted in a quasi-immediate decline in living standards, and increase pressure on relief institutions.

Ruff (1984) shows that deprivation was a major cause of thefts in early modern France. In particular, wheat price movements deeply affected the poorest, and correlates with the rate of theft. Elevated food prices made it more difficult for many households to meet their minimum subsistence needs, leaving thievery as the only solution for survival.[69] Using various population censuses, Nicolas (1978) finds that between 8 and 13 per cent of the households were recorded as poor during normal years, but numbers significantly inflated in times of food shortage. Apart from emigration, another relief was to be found in public assistance. At the individual level, motivations for charity ranged from spiritual movements to conflict over family wealth and search for prestige among elite groups, whereas states authorities' concerns were twofold: the reduction of insecurity, and the education of its people (Cavallo, 1995; Fouquet, 1986).[70] Municipal authorities ran most of the hospitals and other charity institutions with the help of various religious orders.[71] In 1717, an edict required every city and town to create either a hospital or an almshouse, and some flourished after receiving several donations. To make it easier for hospitals and charity institutions to raise funds, state authorities granted them tax exemptions and made it compulsory for notaries to suggest to testators to make a donation to such institutions (Fouquet, 1986).[72]

[69] The desire for revenge, the willingness to settle property disputes without appealing the law, and professional thievery constituted other motivations to commit thefts.

[70] Particularly important at that time was the distinction between the 'good' poor who deserved help, and the unworthy poor, such as able-bodied beggars, lazy and immoral adults, and sometimes foreigners (Jones, 1989).

[71] For a detailed description of public assistance in Savoy, see Bouverat (2013*b*, 266-310). For a comparison with the system of public assistance in Turin, see Cavallo (1995).

[72] The ambition of such scheme was to discourage face-to-face charity, and to direct citizen's charitable acts towards the municipal system of poor relief. Individuals sometimes bequeathed substantial sums of money to charity in their wills. Through the late 1680s, the widow of Mr. Zamondy, a rich merchant from Chambéry, bequeathed the equivalent of 12,300 *florins* to the hospital of *Saint-François et Maché* and *Charité*. In 1775, François Vespre bequeathed £22,000 to the different hospitals in Chambéry (Palluel-Guillard, 1963).

Only the wealthiest could afford such donations, though, and about one-fifth of testators actually donated to charity. In Chambéry, the hospitals of *Saint-François et Maché* and *Charité* had an annual income of nearly ten thousand *florins* and fifty thousand *florins* respectively in the early 18th century. They drew the bulk of their income from private donations, property income, and profits derived from their workhouses. From the mid-1730s onward, the *Hôpital Général* provided outdoor relief to the poor through weekly distributions of bread taking place every Sunday morning after the Mass (Fouquet, 1986).[73] Beside hospitals, which were mostly dedicated to the assistance of the poor and needy, two other types of institutions were providing public assistance. Hostel of God (*Hôtel-Dieu*) and leprosarium focused on the recovery of the ill, while various religious and mendicant orders provided alms to the indigent in times of dire need (Palluel-Guillard, 1963). In 1748, the village of Rumilly experienced a harvest failure. After visiting the village, the Visitandines noticed that "because of the exorbitant price of food, numerous poor are suffering". In the following weeks, the Sisters provided "potage made of vegetables, dry plums, and flour and distributed it once or twice a week to a large number of poor looking pitiable, be they were starving".[74] Similarly, in Moûtiers in 1768, the archbishop set an annual donation to the hospital amounting to 344 hectolitres of grains, to be distributed to poor and individuals affected by frost and fires.

In case of emergency caused by famine and epidemics, municipal and state authorities supplemented the actions of these institutions in the provision of aid to the poor with additional specific actions. The expansion of bureaucratisation in the first mid of the 18th century made it easier for them to monitor socio-economic conditions, and adopt a more interventionist attitude by using anti-dearth measures.

In 1734, misery was so widespread in the province of Savoie after three years of shortage, that several thousands of poor needed to be provided for. Between the 25th of April and the 20th June 1734, the city council of Chambéry spent £6,885 to organise daily distribution of bread and soup at the *Hôpital Général*.[75] A decade later, the king allowed the city council to sell 4,000 bags of wheat from the military stockpile at reduced prices to mitigate the effect of harvest failure. In 1771, the city council of Chambéry decided to borrow £22,000 to be able to import 4,000 bags of wheat from Piedmont. Overall, the sales of wheat to needy inhabitants amounted to £34,605 that year. In 1778, imports from Geneva provided enough grains to feed 3,000 individuals in Chambéry and twenty six surrounding parishes for several weeks (Palluel-Guillard, 1963). In

[73] Poor often had to comply with requirements such as attendance at the Mass, participation at funerals, saying prayers at fixed time, and remaining silent during meals, as parts of the educational effort to redeem themselves.
[74] Cited in Bouverat (2013*b*).
[75] A.M. Chambéry, IR 106, carton 1022.

June 1783, the Laki Craters eruption began and led to the hottest summer in a century, and caused severe thunderstorms and acid rains damaging crops all over Europe, leaving the local population under stress. That year, Sébastien Ribbaz bought on the behalf of the province of Carouges the equivalent of £30,000 of wheat to provide subsistence for the poor.[76]

In the province of Chablais, the community secretary of Évian, the notary Cottet, had to buy 266 bags of wheat from Sardinia to relieve 20 communities. Abundant snow had delayed the harvest by a month, before a hailstorm caused serious damage to the crops, and left several of these communities in absolute misery. On March 30, Cottet further requested the king to loan him £5,000 to 6,000 to buy more grain.[77] One month and half later, the minister De Mouroux wrote to the intendant general in Chambéry to gather information on how Cottet was using the £4,000 loan he received from the king. In addition, De Mouroux reminded the intendant the necessity to send grain to Onnion and the surrounding parishes, which needed it to crop their fields.[78] In late August 1771, the city council of Le Biot informed the local intendant that, thanks to the crops provided in May, they were able to harvest thirty-eight hectolitres of barley and about ten hectolitres of oat, thus eliminating the risk of famine.[79]

Municipal and state authorities worked together to cope with the challenges raised by transitory poverty shocks, and improve the provision of poor relief in time of distress. Between 1750 and 1789, about fifty episodes of riots occurred in Savoy, but only five of which were related to the question of subsistence riots (Nicolas, 1973, 1974). This evidence suggests that the system of relief was successful in absorbing most of the negative effect of weather-induced poverty shocks. To document this, I match data on social conflicts from Nicolas (1973, 1974) with measure of temperature shocks by season by year by province. I run panel regressions with province fixed effects and time fixed effects to estimate the reduced-form effect of temperature shocks on the onset of social conflicts. Table 14 reports results and suggests that there was no clear statistically significant relationship between temperature shocks and social conflicts in 18th-century Savoy. This, in turn, means that either local communities were very resilient at the aggregate level and did not mean to resort to riots in times of dire need or

[76] Cities and towns were generally very active in the provision of assistance. On March 7, 1783, the city council of Chambéry decided to create a commission to identify families in need in the different neighbourhoods and to distribute them the relief they needed. Since the beginning of the 18th century, the city council was also offering annually free apprenticeship to six orphans originating from the city, and provided six poor young women with dowries. In Saint-Jean-de-Maurienne, the city council decided in 1758 to offer four hundred *livres* a year to attract a new physician in town. In following years, several cities, including Carouge, Moûtiers, and Termignon, used similar design to attract new physicians.

[77] A.D. Haute-Savoie, 1 C, 2 73, pièce 19.

[78] A.D. Haute-Savoie, 1 C, 2 73, pièce 29.

[79] 48 *coupes* and 2 *quarts* of Thonon, and 12 *coupes* of Thonon, respectively. A.D. Haute-Savoie, 1 C, 2 73, pièce 229.

Savoyard authorities were able to provide sufficient relief to prevent the occurrence of popular disorders.

A.2 A mixed agro-pastoral system

By the mid-18th century, Savoy was a rural rain-fed agrarian economy with two distinctive characteristics.[80] First, the collective ownership and use of commons was particularly developed. On average, about 48 per cent of the total land area was common land, a rate reaching 72 per cent in the mountainous provinces of Tarentaise and Maurienne (Guichonnet, 1955, 1969; Nicolas, 1978).[81] Common land often constituted a safety net for small landholders and the poor by providing them with valuable income in the form of pasture, in particular in time of dire need (Baud, 2010; Bloch, 2015; Scuiller, 2008).[82] Second, pastures, and therefore livestock, occupied a predominant position in the agricultural landscape. Arable land represented only a third of the agricultural land area, and pastures about half. The remaining land was occupied by forests, orchards and vineyards.[83]

Disparities in agricultural practices, however, existed between lowlands and uplands where extensive grazing was more readily available (Charbonnier, 2002). In addition, although grass growth diminished with increasing elevation, the higher exposure to sunshine resulted in higher protein and fat contents. Milk from upland-grazing animals was thus creamier, and products derived from it, such as cheese and butter, fatter (Orland, 2004). The composition of highland pastures also had an impact on both the chemical and the rheological characteristics of the cheese. Overall, cheese was better in quality parameters for human nutrition than that produced from milk of indoor fed animals. More importantly, cheeses produced on mountain pastures were less elastic and less deformable than those produced with milk from valley pastures. The harder a cheese was, the longer it could be stored and transported, and therefore, the higher was its price (Bugaud et al., 2001; Galina et al., 2007).

[80] Until the early 19th century, the development of industries was very limited in Savoy, but in Cluses and Faverges, which specialised in watchmaking and paper industry respectively (Armand, 1974, pp. 97-108).

[81] These figures are extremely high for pre-modern Europe, but not unusual in the Alps. In the neighbouring Briançonnais, collectively-owned pastures represented 70 per cent of the total land area (Vivier, 1990). In the mid-18th century, between one-tenth and one-sixth of total land area was commons in France, and about 20 per cent in England (Béaur, 2006; Plack, 2013; Vivier and Corbin, 1998).

[82] Every household, however, were not wealthy enough to have livestock. In the area of Beaufort, 21 per cent of the 540 households owned no cattle at all in 1763. In Saint-Pierre d'Albigny, one-third of households owned no cattle in 1786 (Becchia et al., 2012; Viallet, 1993). Orland (2004) suggests that the ownership of six to eight cows was already a sign of prosperity. With four cows, a family usually managed to generate food surplus and to feed one or two pigs (Devos and Grosperrin, 1985).

[83] Wheat was cultivated on a third of the arable lands, whereas fallows and other crops and fodder occupied the remaining two thirds.

Lowland farmers could also benefit from these advantages through leasing or renting out land, but large differences persisted across provinces. On average, 73 per cent of the cattle were herded up to Alpine pastures in summer in the province of Tarentaise, but only 29 per cent in the province of Savoie (Becchia et al., 2012). However, keeping cattle in stalls also had advantages, such as easier milk and manure collection, and available fields to plant fodder plants, like sainfoin. Cattle were usually herded up to highest pastures from late spring to early fall, after what they were brought to lower altitudinal meadows for a month before either returning to the barn for winter, or being sold or slaughtered. Animals were fed through the winter with the hay harvested in lower farming stages in spring and late fall. Harsh winter, however, reduced the number of degree days and the amount of available hay, whereas the need for fodder was higher.[84] Upland farmers could then either sell parts of their herd or buy additional fodder from lowland farmers.[85] Thus, in 1770, the intendant of Chablais reported that, due to the scarcity of fodder, the inhabitants of Belleveaux were "forced to sell lots of their livestock, which were their unique resources, leaving them in a regrettable situation [...], as it already happened after the frost of 1740 and 1758".[86] Income derived from the sale of livestock in the neighbouring cities, mostly Geneva and Turin, was significant. Grillet (1807) indicates that about 25,000 heads of livestock were sold annually in Turin. That represented an annual capital inflow of approximately one million *livres*. Additionally, about 210 tons of butter were also exported to Piedmont every year, and about 25,000 cheese wheels were sold in France and Switzerland.[87]

More generally, there was on average 0.62 cattle per inhabitant, but up to two times more in places like Saint-Jean-de-Sixt and Grand-Bornan (Becchia et al., 2012).[88] In comparison,

[84] During normal years, a cow needed between 25 and 30 *trousses* of hay, whereas a heifer needed only 15 *trousses*. Sheep and goats needed about 5 *trousses* of hay. A *trousse* is a unit of weight equal to 85 kg (Tracq, 2000).

[85] Another recurrent problem in upland areas was overgrazing. During the 18th and 19th centuries, the expansion of livestock breeding led to tree loss and deforestation, which fostered the occurrence of flooding in lowlands (Crook et al., 2002, 2004). Demographic expansion and the development of mining and metal manufacturing industries in the late 18th century increased local demand for firewood and charcoal, thereby also increasing the pressure on forestry resources (Marston, Bravard and Green, 2003). Interestingly, Crook et al. also suggest that changes in dietary habits had an impact on woodlands. The spread of potatoes cultivation in the 1770s reduced reliance on chestnuts, a central staple in mountains diets, leading to a decline in the importance of chestnut trees. In 1729, 1766, and 1770, the state enforced new forest regulations, such as the ban of wood exports, in an attempt to reduce the destruction of forests. The possibility of selling wood to sustain a livelihood, absentee landlords, and the difficulty to exert controls on backward areas, however, rendered these regulations relatively ineffective.

[86] A.D. Haute-Savoie, 1 C, 2 72, pièces 138.

[87] On average, one head of cattle cost between £41 and 45 (Becchia et al., 2012). According to Grillet, in 1792, the total amount of butter exported to Piedmont amounted to 25,000 rups of Piedmont. The rup of Piedmont is unit of weight equal to 8.544 kg. For a general discussion on the importance of livestock trading in the Alpine region, see Mathieu (2009, pp. 121–2).

[88] In few villages, like Abondance and Bellevaux, the situation was even more exceptional with 810 cattle for 164 inhabitants and 836 cattle for 185 inhabitants, respectively.

England and France had much lower livestock portfolios in 1750, be there were about 0.14 and 0.32 cattle per capita respectively.[89] Even in the neighbouring province of *Dauphiné* in France, cattle breeding was not so central. In the district of Grenoble, there was 0.43 cattle per person in 1748, and, in the mountainous districts of Queyras and Briançonnais, the rate dropped to 0.28 and 0.27. By offering meat, hides, and dairy products, and the possibility to quickly adjust one's wealth portfolio, livestock is a particularly interesting asset to smooth consumption level over time. In addition, manure, as a natural fertiliser, helps to replenish nutrients in the soil and to maintain agricultural yields. Goubert (1960) argues that this set of elements helped individuals to better cope with climate vicissitudes in mountain pastures areas than in grain-growing plains.[90]

To investigate this question, I compare the effect of year-to-year variations in temperature, a proxy for transitory income shock, in provinces with high level of livestock breeding to the effect of year-to-year variations in temperature in areas with little livestock breeding. My regression model is the following:

$$\begin{aligned} Crime_{ist} = \beta_1 \, Temperature_{its} + \beta_2 \, Temperature_{ist} \\ \times \, Livestock_i + \delta_i + \delta_t + \epsilon_{ist} \end{aligned} \tag{2}$$

where $Crime_{its}$ denotes the log of the number of *Total crime* per 100,000 inhabitants– respectively *Violent crime* and *Property crime*– in province i in season s in year t. $Temperature_{its}$ is the seasonal standardised temperature deviation from the long-term mean (1500–1600) in province i during season s in year t. $Livestock_i$ is (i) a dummy variable equal to one if the average number of livestock heads per inhabitant in province i is above the Savoyard mean, and zero otherwise (intensive margins); (ii) a continuous variables equal to the average number of livestock heads per inhabitant in province i (Extensive margins). δ_i are province fixed effects and account for time-invariant province characteristics. δ_t are year fixed effects, and account for time-variant characteristics that may affect all provinces at the same time. Standard errors are clustered at the provincial level. The β_1-coefficient capture the effect of temperature shocks on the incidence of crimes, whereas the β_2-coefficient indicates the differential effect between provinces with high rate of livestock breeding, and provinces with lower rate.

Table 15 and Table 16 present the results. The point estimates in column 1 tend to show that livestock breeding had a positive effect on total crime, but this result is not statistically

[89] Clio Infra database: https://www.clio-infra.eu.

[90] Besides, Nicolas (1978) contends that the least presence of overlordship in uplands also reduced fiscal pressure and the hindering for agricultural improvements, leaving communities theoretically better off than their lowland counterparts.

significant. In column 2 of Table 15, the coefficient of the variable *Temperature* $\times$ *Livestock* is positive and statistically significant at the 1% level. The effect of temperature shocks on violent crimes is significantly higher in provinces in which livestock breeding is widespread, relative to other provinces. Focusing on extensive margins yields similar results (column 2 in Table 16). Results presented in column 3 of Table 15 and Table 16 indicate that livestock had no statistically significant effect on property crimes. These mixed findings provide some support to the fact that livestock can be an efficient buffer against weather-induced income shocks. Local communities with higher level livestock breeding were better able to cope with temperature shocks and smooth consumption over time. In a Mehlum, Miguel and Torvik (2006)'s 'framework', this implies that these communities could maintain their level of alcohol consumption, which in turn resulted in higher violent crime propensity. Another stream of literature focuses on the relationship between economic inequality and crime. For instance, Enamorado et al. (2016), and Fajnzylber, Lederman and Loayza (2002) show that income inequality and violent crime are positively correlated, even after controlling for other crime determinants. Unfortunately, I lack data on economic inequality at the provincial level, so I can not control for this mechanism. Historical evidence, however, indicates that the "consumption smoothing effect" is more likely to explain these results than the inequality arguments.

Table 14: Temperature shocks and social conflicts in Savoy (1650–1789)

	Full sample		Sample 1749–89	
	Social conflicts	Subsistence conflicts	Social conflicts	Subsistence conflicts
	(1)	(2)	(3)	(4)
Temperature	0.195	−0.142	0.195	−0.142
	(0.227)	(0.134)	(0.234)	(0.128)
Province FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	3,348	3,348	3,348	3,348
Mean DV	4.87	0.36	7.66	0.62

Notes: Significant at ***1%, **5%, *10%. Panel linear estimations with province fixed effects and year fixed effects. Cluster bootstrapped standard errors in parentheses (Cameron et al., 2008).
In column 1, the dependent variable equals 100 if at least one social conflict occurred in province *i* during season *s* in year *t*, and zero otherwise. In columns 2 to 5, the other dependent variables are defined accordingly for subsistence-related conflict, fiscal conflict, conflict against state authorities, and other types of conflict. In Panel B, dependent variables are defined accordingly, but are restricted to conflicts involving more than fifty individuals. The independent variable Temperature is the seasonal temperature deviation from the long-term seasonal mean (1500–1600) in province *i*, divided by its standards deviation. Province FE is a full set of province fixed effects. Year FE is a full set of year fixed effects.

Table 15: The effect of livestock breeding: Intensive margins

	Total crime	Violent crime	Property crime
	(1)	(2)	(3)
Temperature	-0.051^{***}	-0.126^{***}	0.034
	(0.020)	(0.021)	(0.025)
Temperature × Livestock	0.064	0.133^{***}	0.002
	(0.078)	(0.041)	(0.084)
Province FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	966	966	966

Notes: Significant at ***1%, **5%, *10%. Panel linear estimations with province fixed effects and year fixed effects. Cluster bootstrapped standard errors in parentheses (Cameron et al., 2008).
In column 1, the dependent variable is the log of total number of crimes per 100,000 inhabitants in province *i* during season *s* in year *t*. In columns 2 to 3, the dependent variables are defined accordingly for violent crimes, and property crimes. The independent variable Temperature is the seasonal temperature deviation from the long-term seasonal mean (1500–1600) in province *i*, divided by its standard deviation. Livestock is a dummy variable equal to one if the average number of livestock heads (including ox, calfs, heifers, and cows) per inhabitant in province *i* is above the Savoyard mean, and zero otherwise. Province FE is a full set of province fixed effects. Year FE is a full set of year fixed effects.

Table 16: The effect of livestock breeding: Extensive margins

	Total crime	Violent crime	Property crime
	(1)	(2)	(3)
Temperature	−0.057	−0.425***	0.224
	(0.200)	(0.139)	(0.180)
Temperature × Livestock	0.043	0.547**	−0.300
	(0.336)	(0.249)	(0.293)
Province FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	966	966	966

Notes: Significant at ***1%, **5%, *10%. Panel linear estimations with province fixed effects and year fixed effects. Cluster bootstrapped standard errors in parentheses (Cameron et al., 2008).
In column 1, the dependent variable is the log of total number of crimes per 100,000 inhabitants in province *i* during season *s* in year *t*. In columns 2 to 3, the dependent variables are defined accordingly for violent crimes, and property crimes. The independent variable Temperature is the seasonal temperature deviation from the long-term seasonal mean (1500–1600) in province *i*, divided by its standard deviation. Livestock is a continuous variable equal to the rate livestock heads (including ox, calfs, heifers, and cows) per inhabitant in province *i*. Province FE is a full set of province fixed effects. Year FE is a full set of year fixed effects.